US011358825B2

(12) **United States Patent**
Yoshida et al.

(10) **Patent No.: US 11,358,825 B2**
(45) **Date of Patent: Jun. 14, 2022**

(54) **POST PROCESSING APPARATUS AND IMAGE FORMING SYSTEM**

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(72) Inventors: **Nagayasu Yoshida**, Kanagawa (JP); **Akihiro Tsuno**, Kanagawa (JP)

(73) Assignee: **Ricoh Company, Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/237,446**

(22) Filed: **Apr. 22, 2021**

(65) **Prior Publication Data**

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(30) **Foreign Application Priority Data**

Apr. 28, 2020 (JP) JP2020-079463

(51) **Int. Cl.**
B65H 37/04 (2006.01)
B65H 31/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***B65H 37/04*** (2013.01); ***B31F 5/001*** (2013.01); ***B41L 43/12*** (2013.01); ***B65H 31/04*** (2013.01); ***B65H 31/34*** (2013.01); *B65H 2301/4213* (2013.01); *B65H 2408/12* (2013.01); *G03G 2215/00822* (2013.01); *G03G 2215/00827* (2013.01); *G03G 2215/00848* (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

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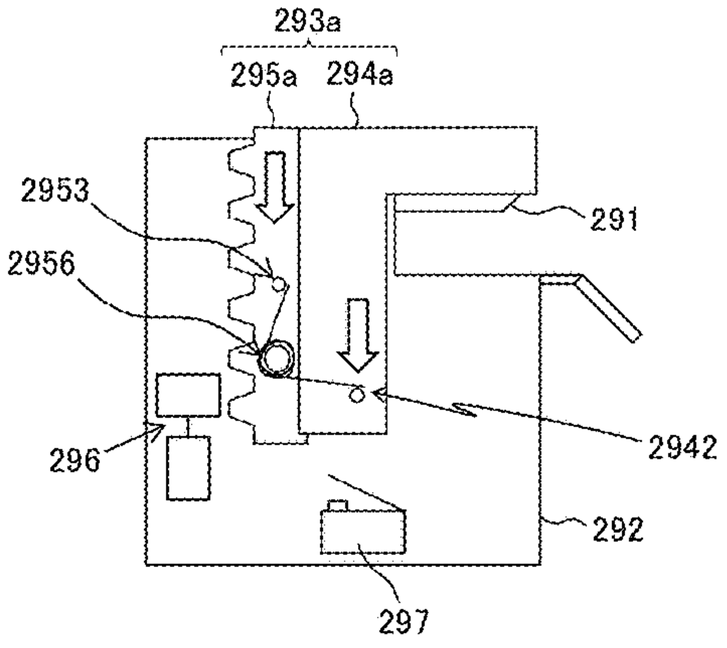
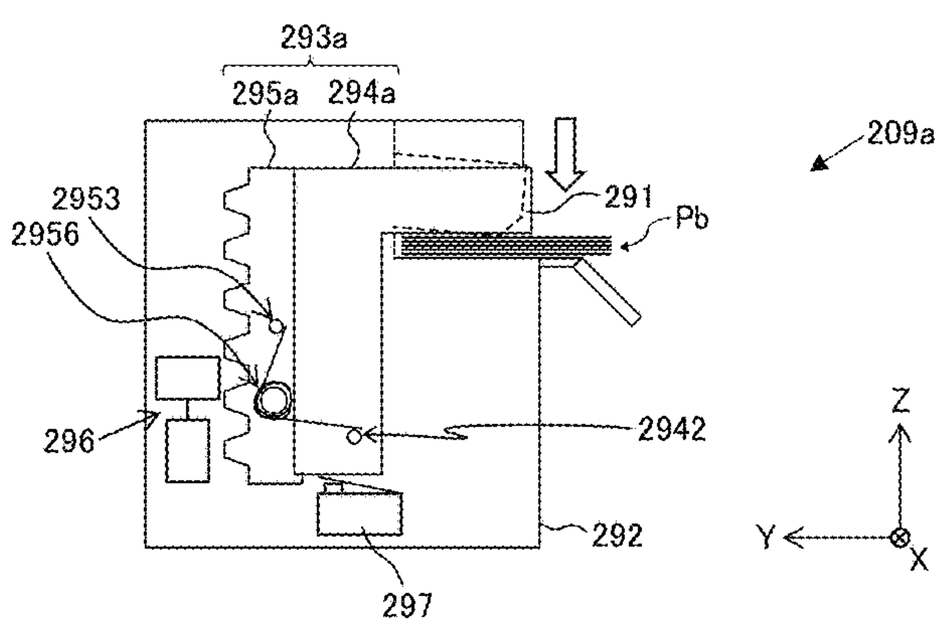
Primary Examiner — Leslie A Nicholson, III
(74) *Attorney, Agent, or Firm* — Harness, Dickey & Pierce, P.L.C.

(57) **ABSTRACT**

A post-processing apparatus includes a binding device, a closing device, a driver, and a changeover switch. The binding device binds a sheet bundle. The closing device closes an entrance to a binding position at which the binding device binds the sheet bundle. The driver moves the closing device to a closing position to close the entrance. The switch performs switching to implement a state in which the binding device is able to bind the sheet bundle when the closing device moves to the closing position. The closing device includes an avoidance operation portion to move to the closing position to operate the switch, and a drive coupler coupled to the avoidance operation portion to move the avoidance operation portion to the closing position. A coupling state between the avoidance operation portion and the drive coupler is released when movement of the avoidance operation portion to the closing position is prevented.

9 Claims, 24 Drawing Sheets





(51) **Int. Cl.**

B65H 31/34	(2006.01)
B31F 5/00	(2006.01)
B41L 43/12	(2006.01)

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FIG. 1

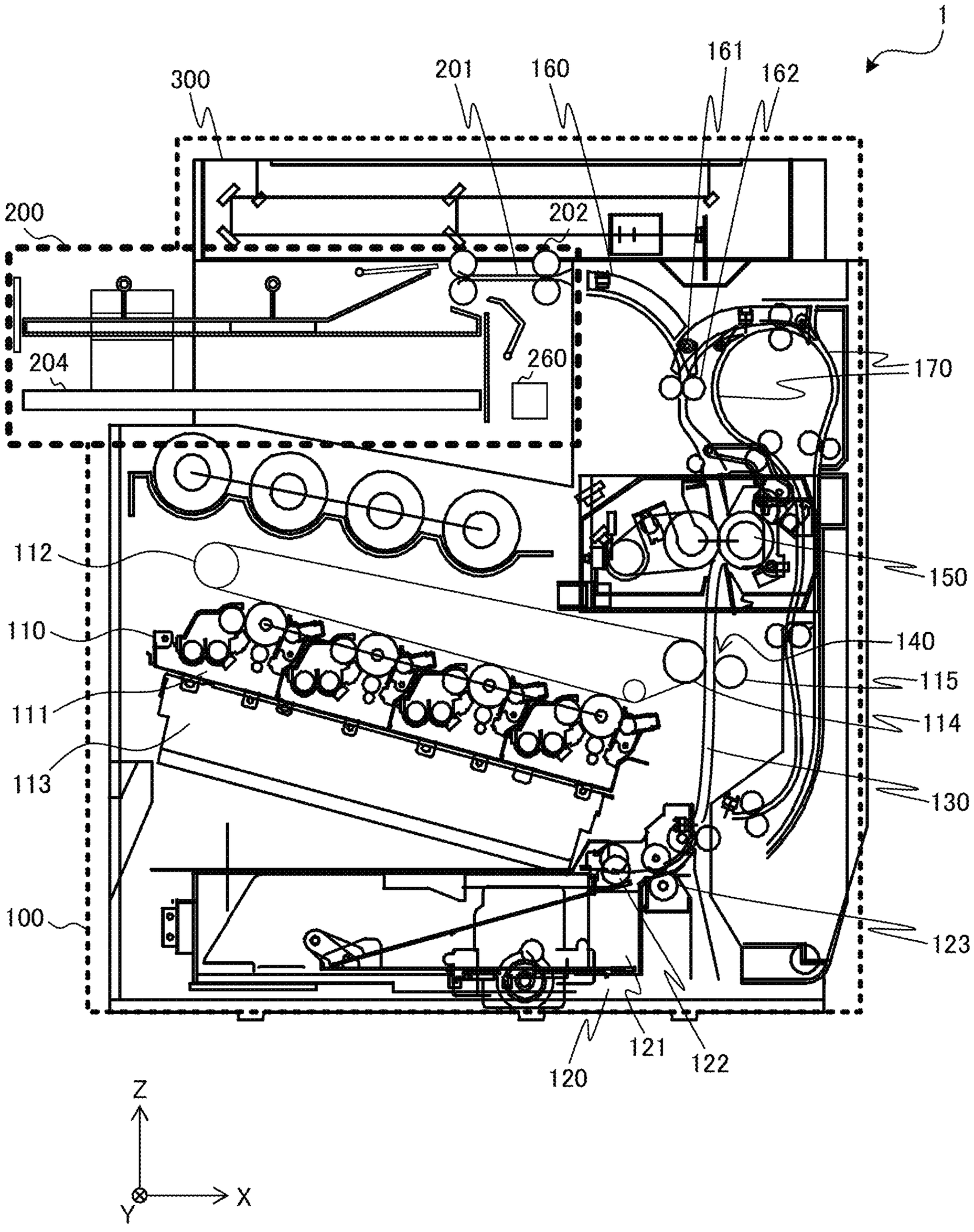

1
300
201
160
161
162
200
202
204
260
170
112
150
110
140
115
111
114
113
130
100
123
120
121
122
Z
Y
X

FIG. 2

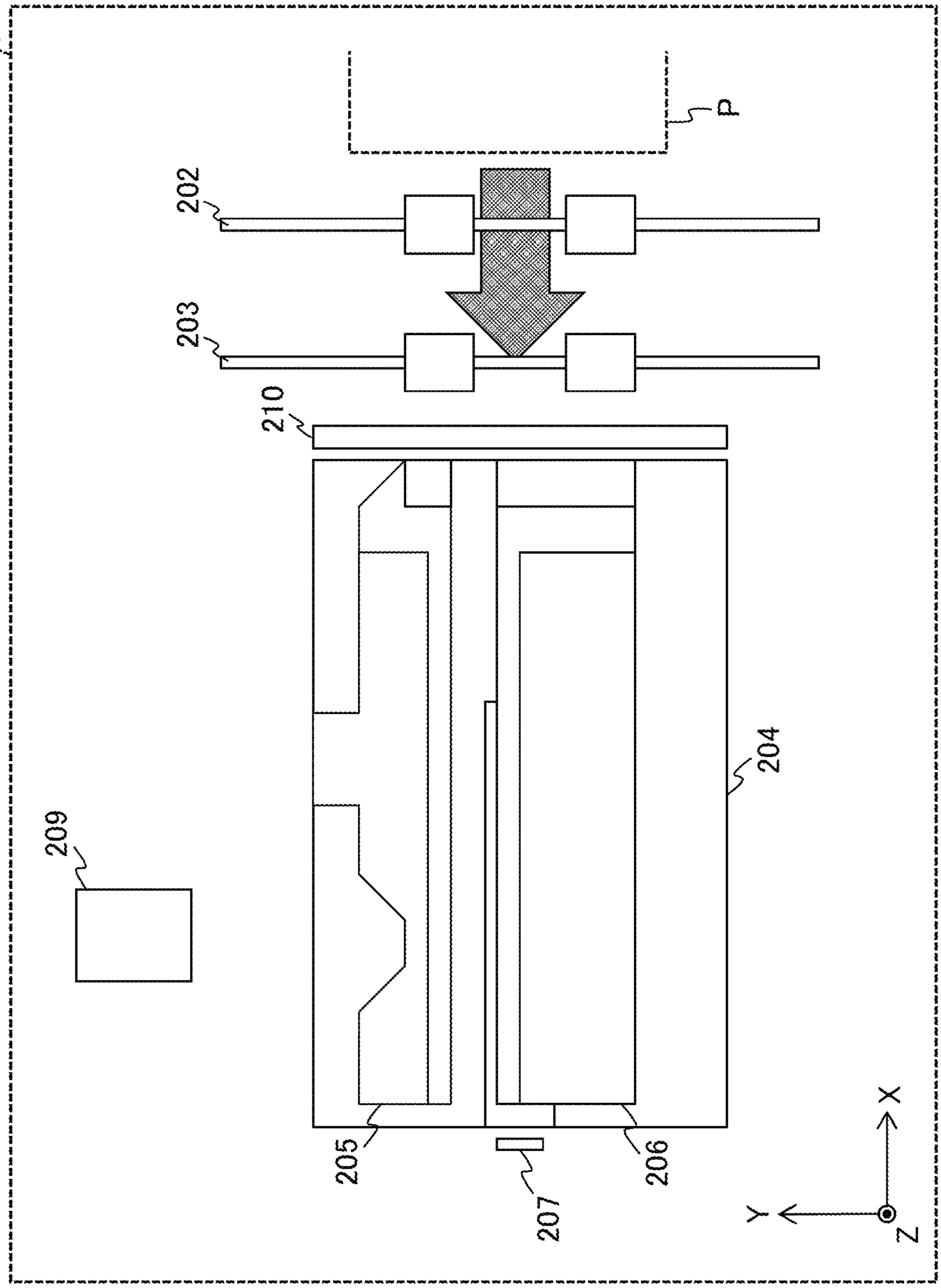


FIG. 3

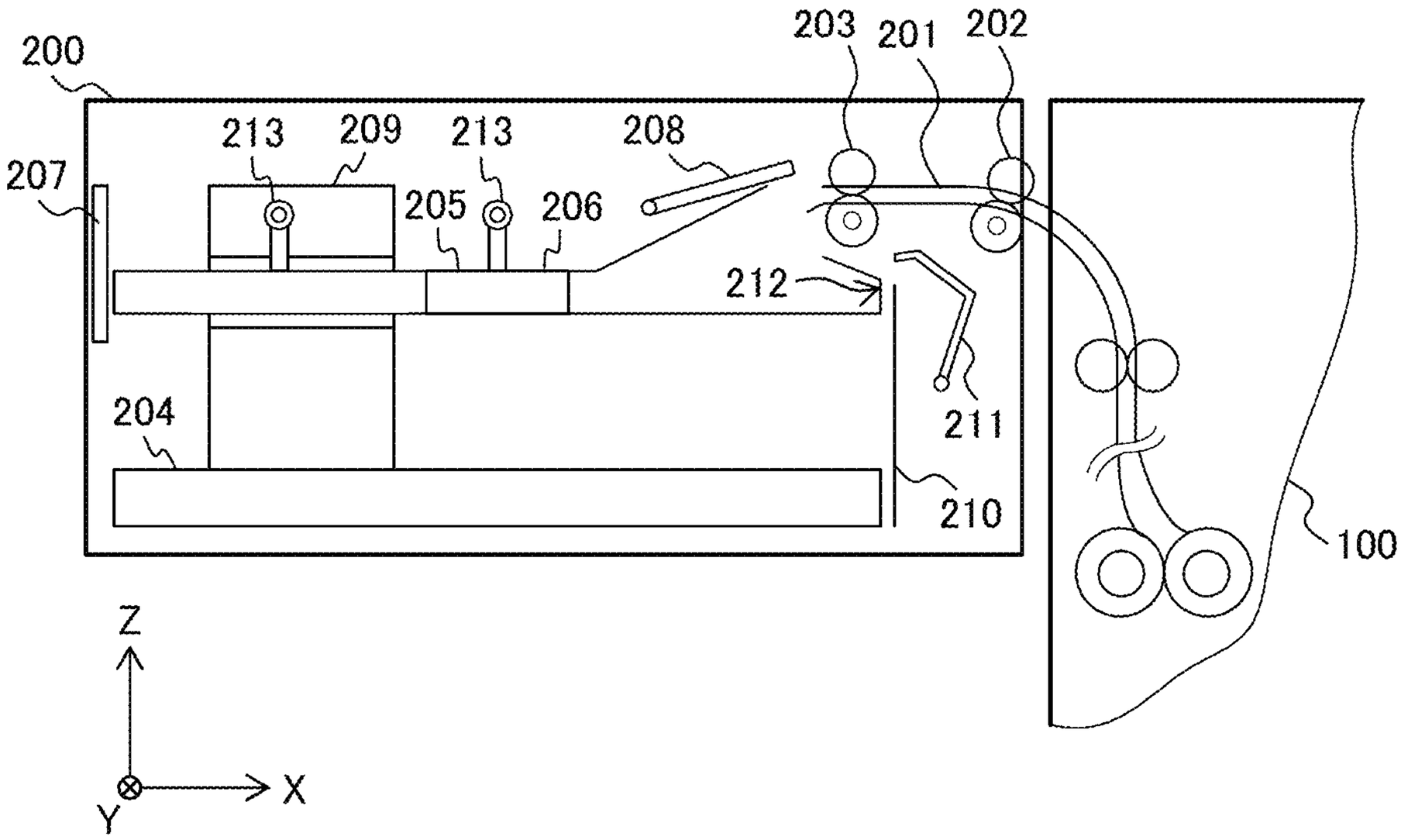
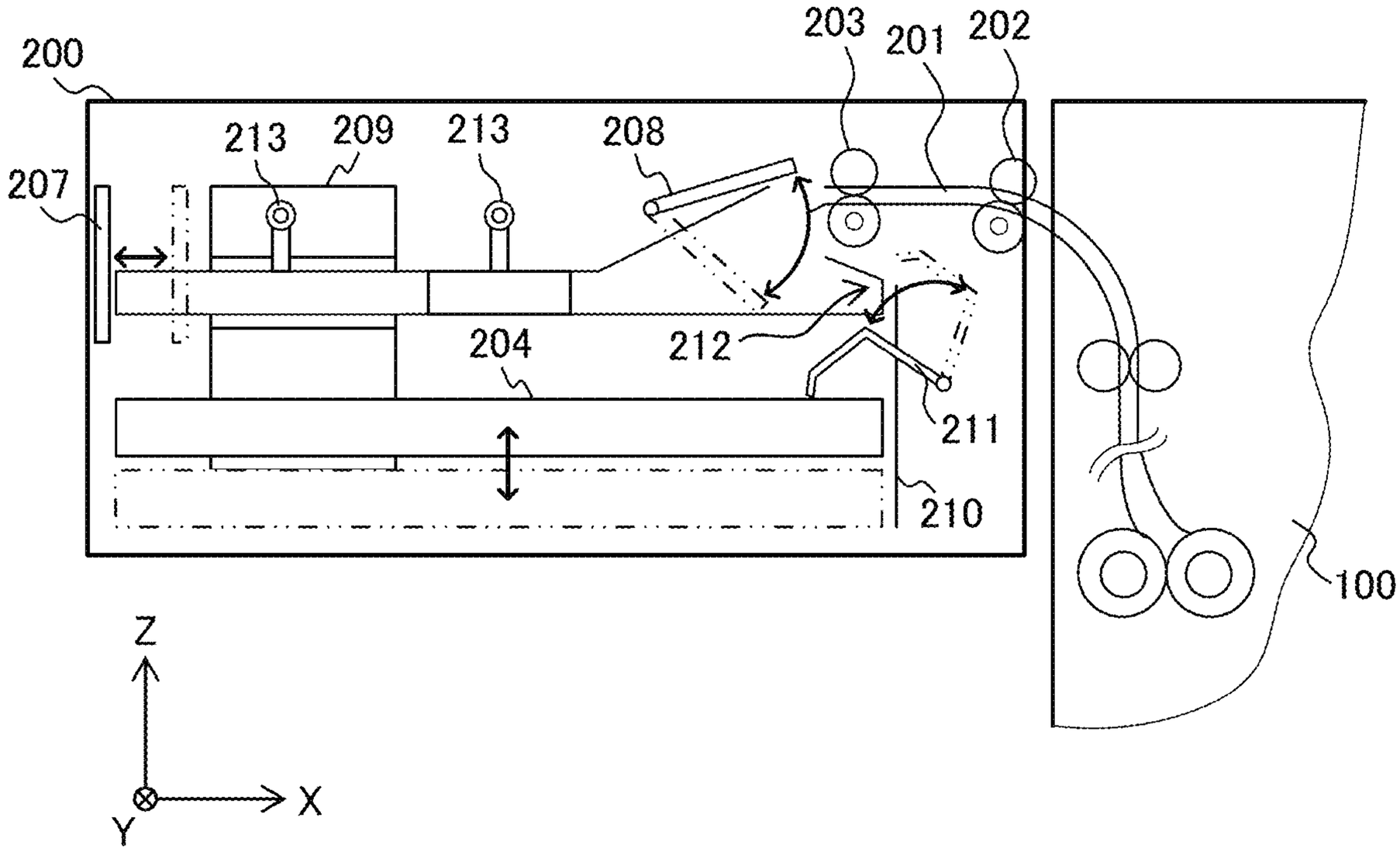

200
203
201
202
213
209
213
208
207
205
206
212
204
211
210
100
Z
X
Y

FIG. 4


200
203
201
202
213
209
213
208
207
204
212
211
210
100
Z
X
Y

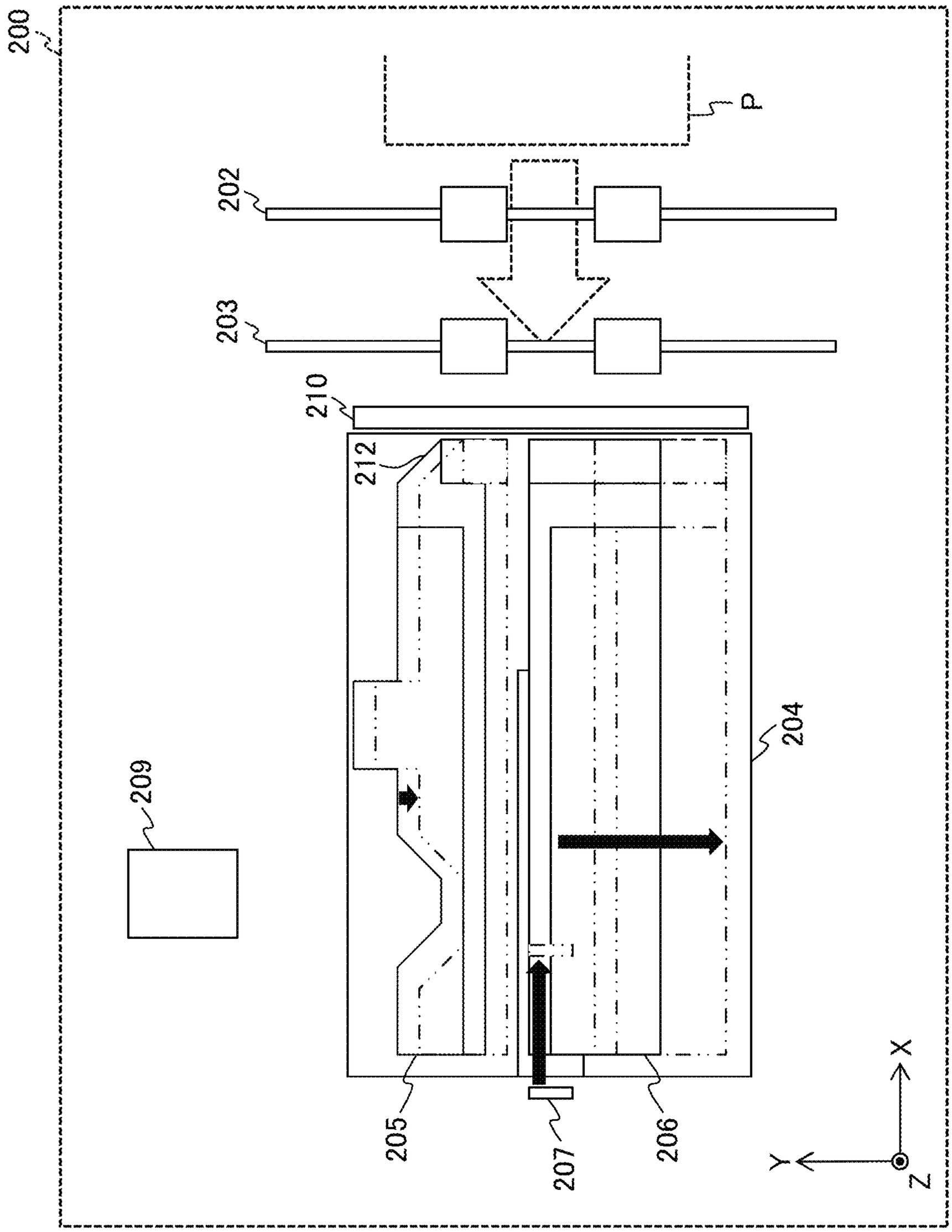


FIG. 5

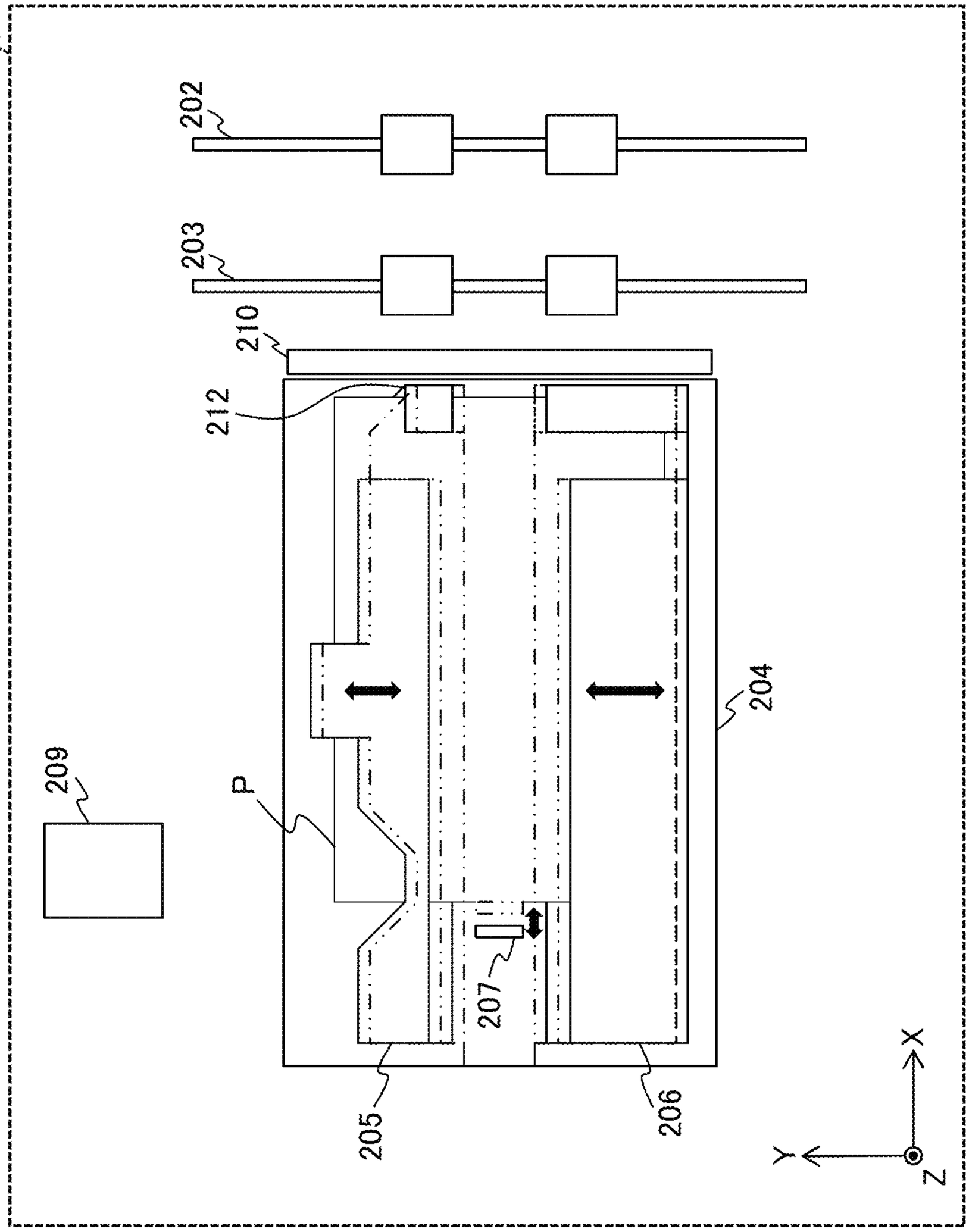


FIG. 6

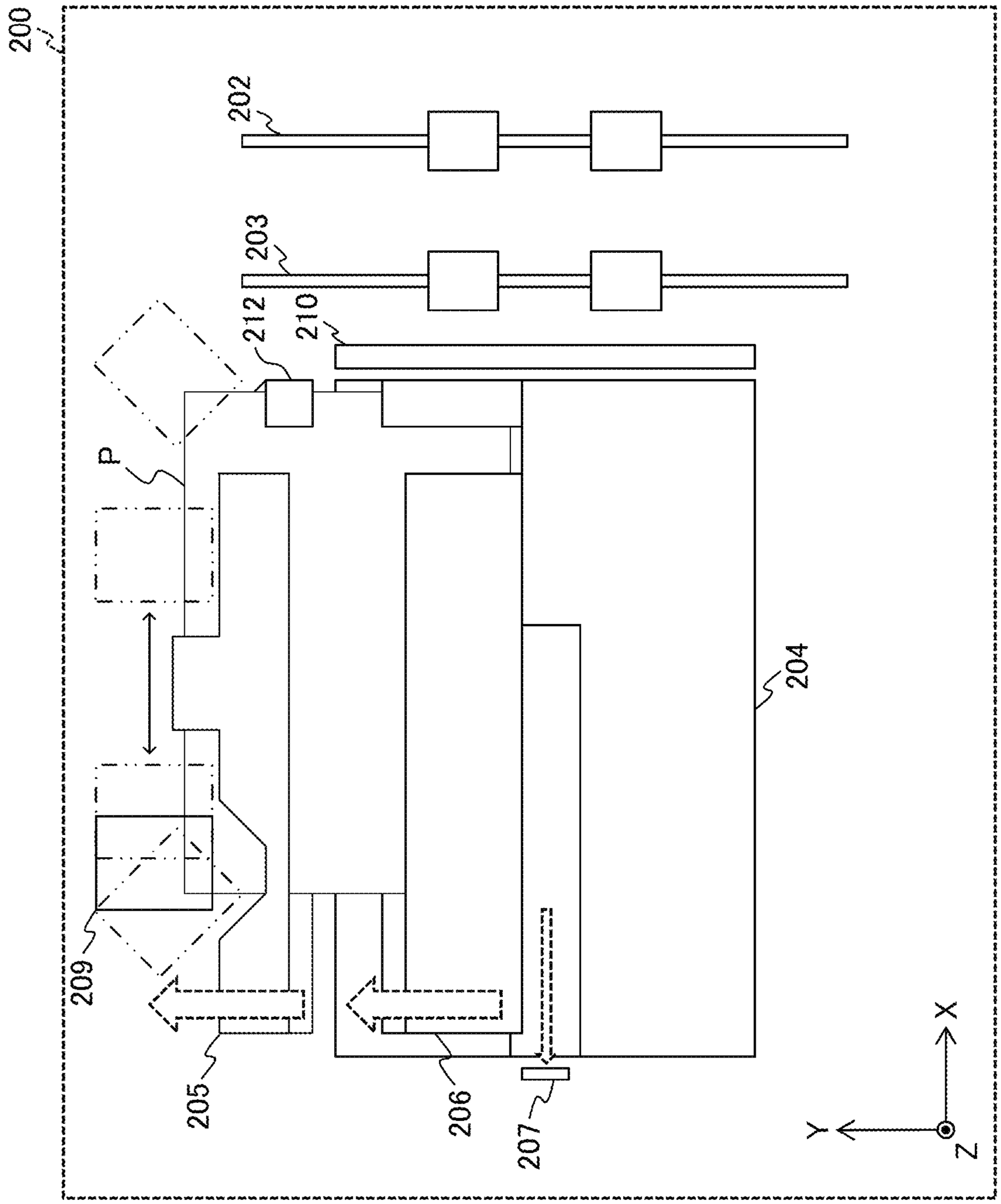


FIG. 7

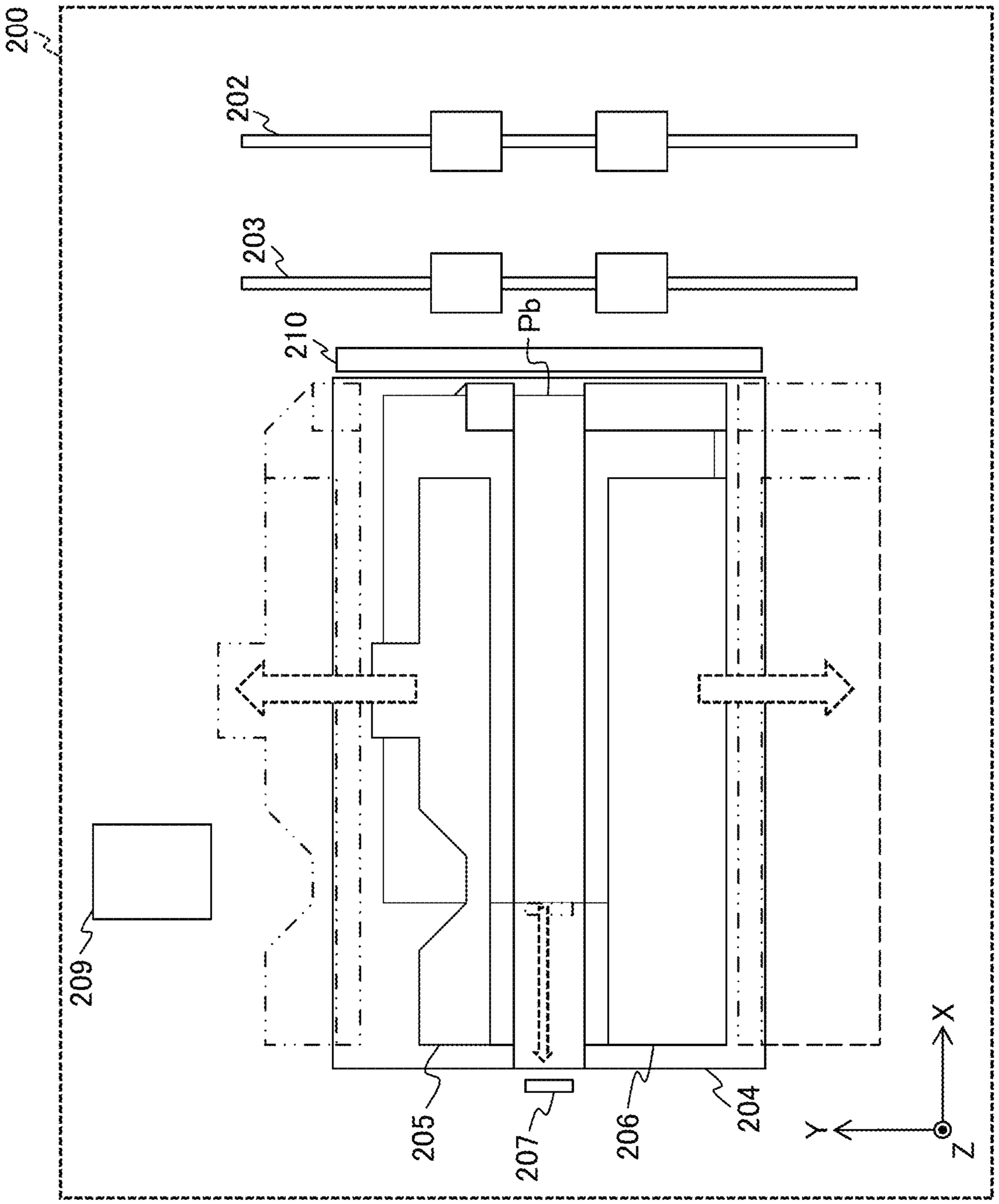


FIG. 8

FIG. 9A

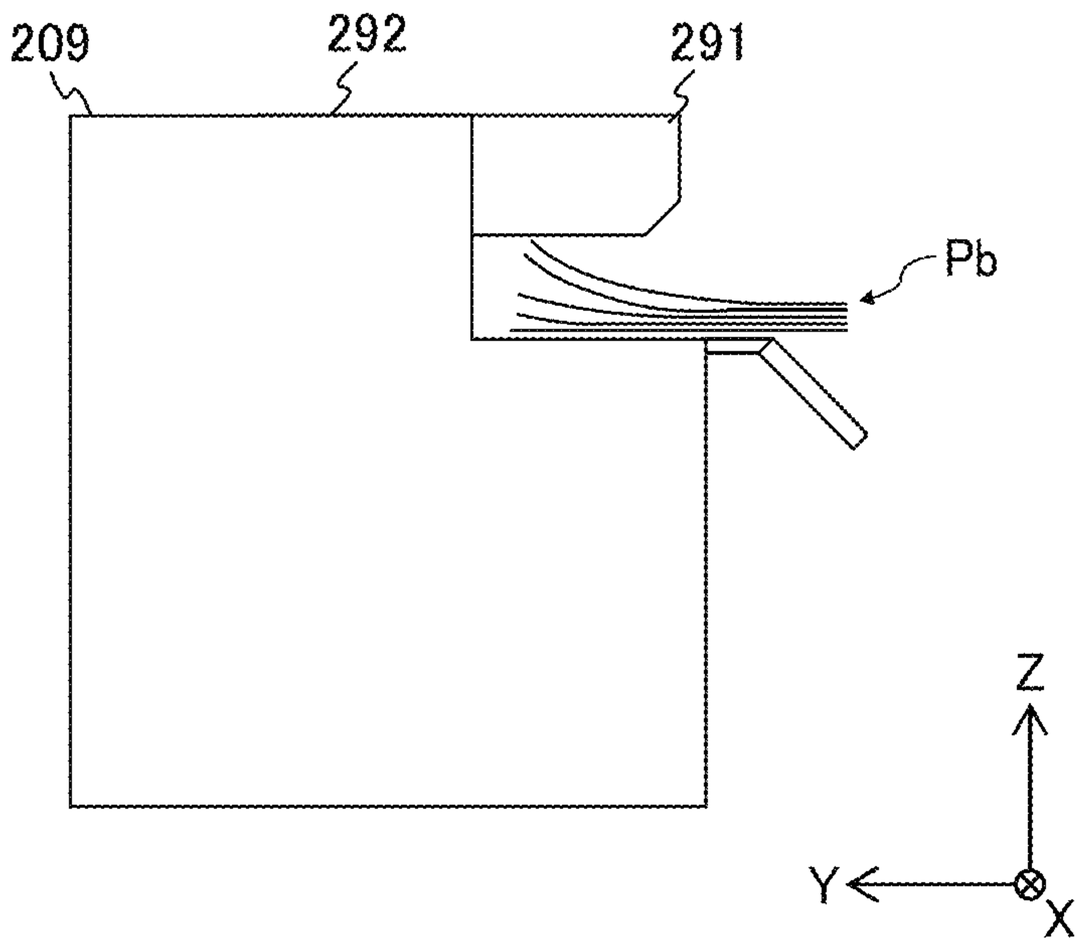


FIG. 9B

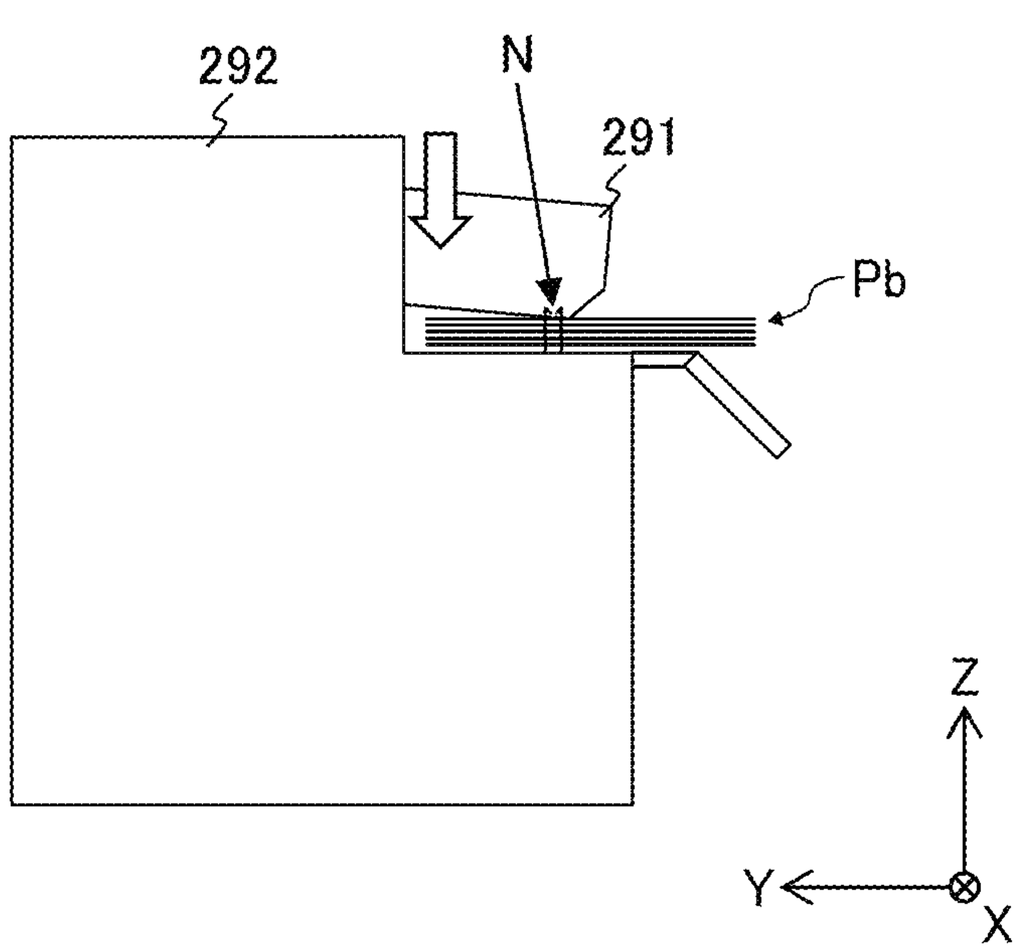


FIG. 10A

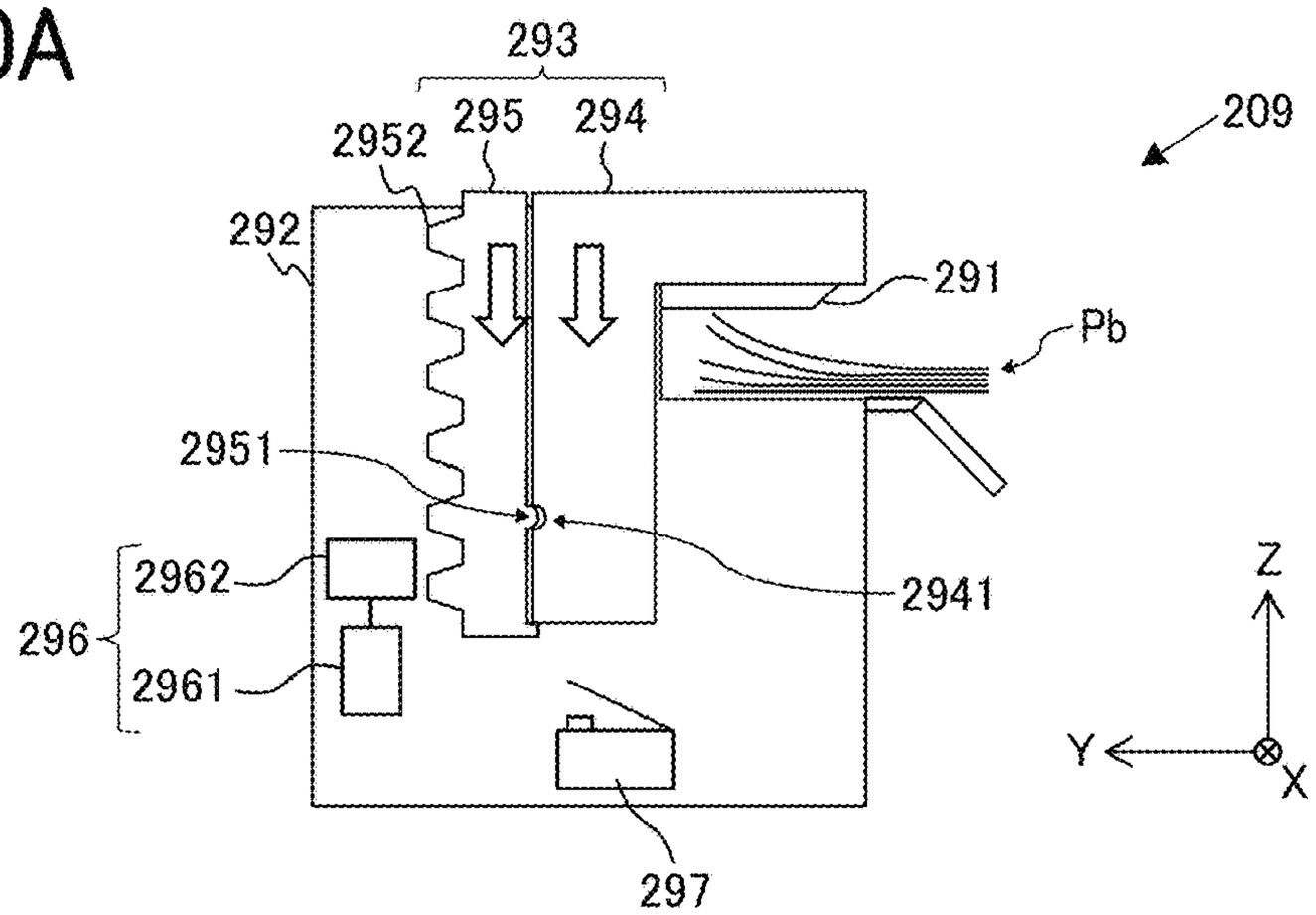


FIG. 10B

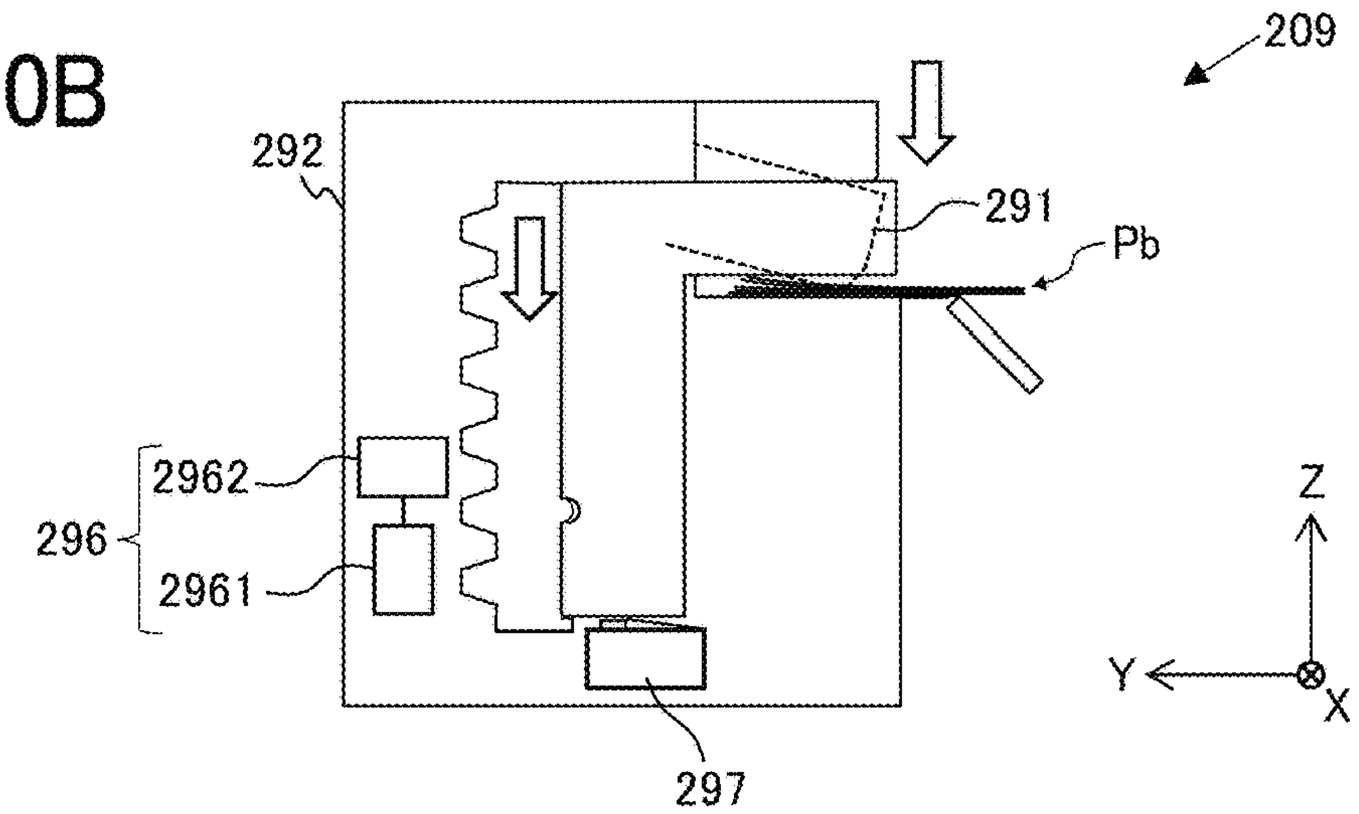


FIG. 10C

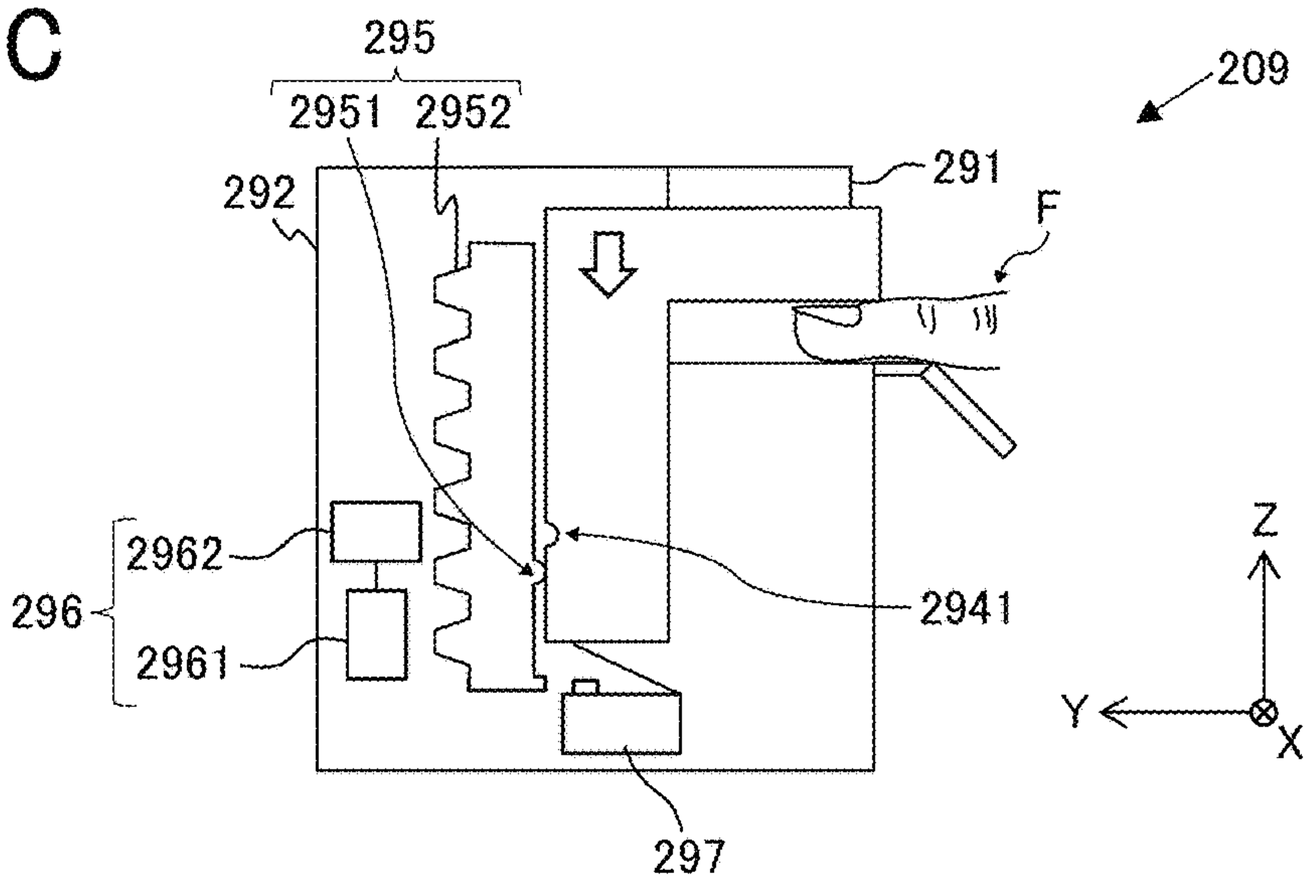


FIG. 11A

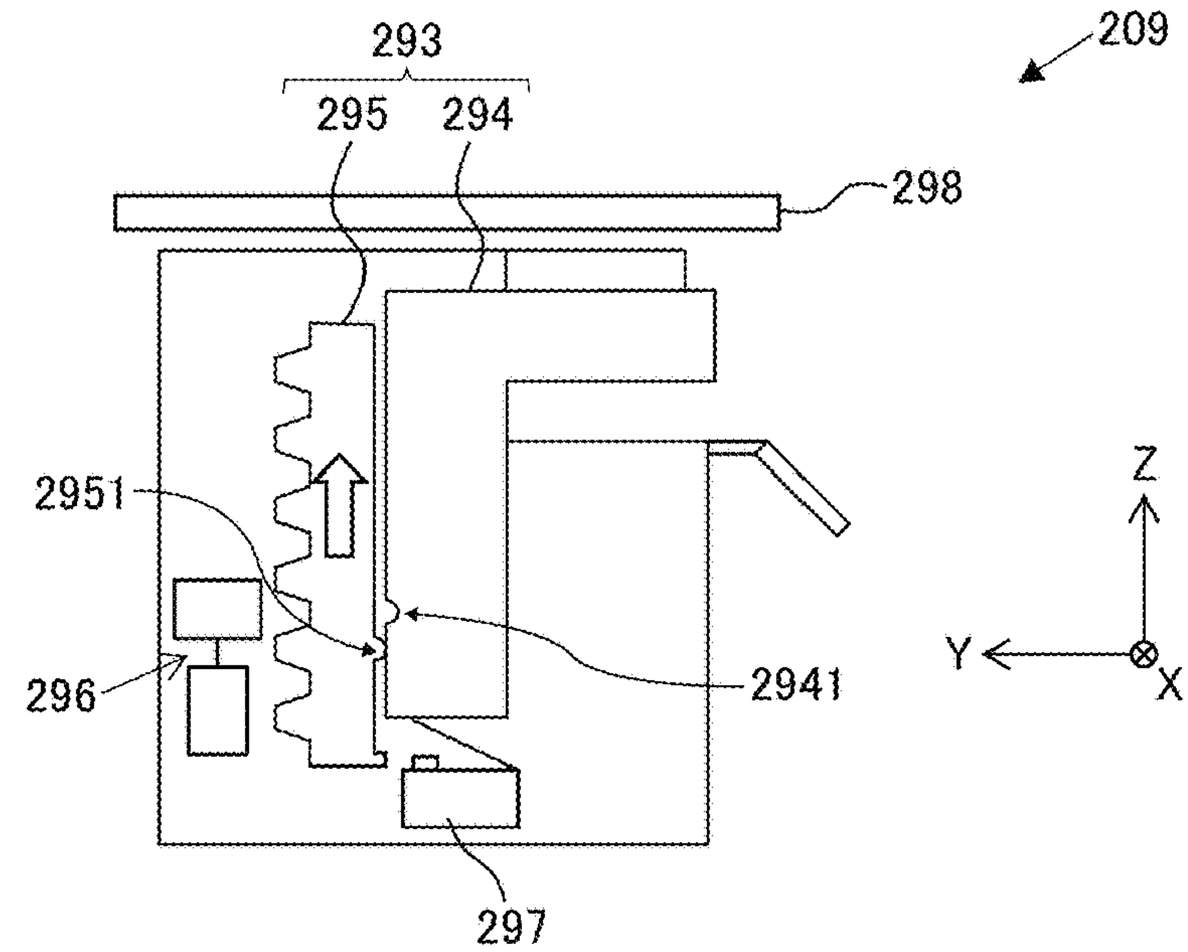


FIG. 11B

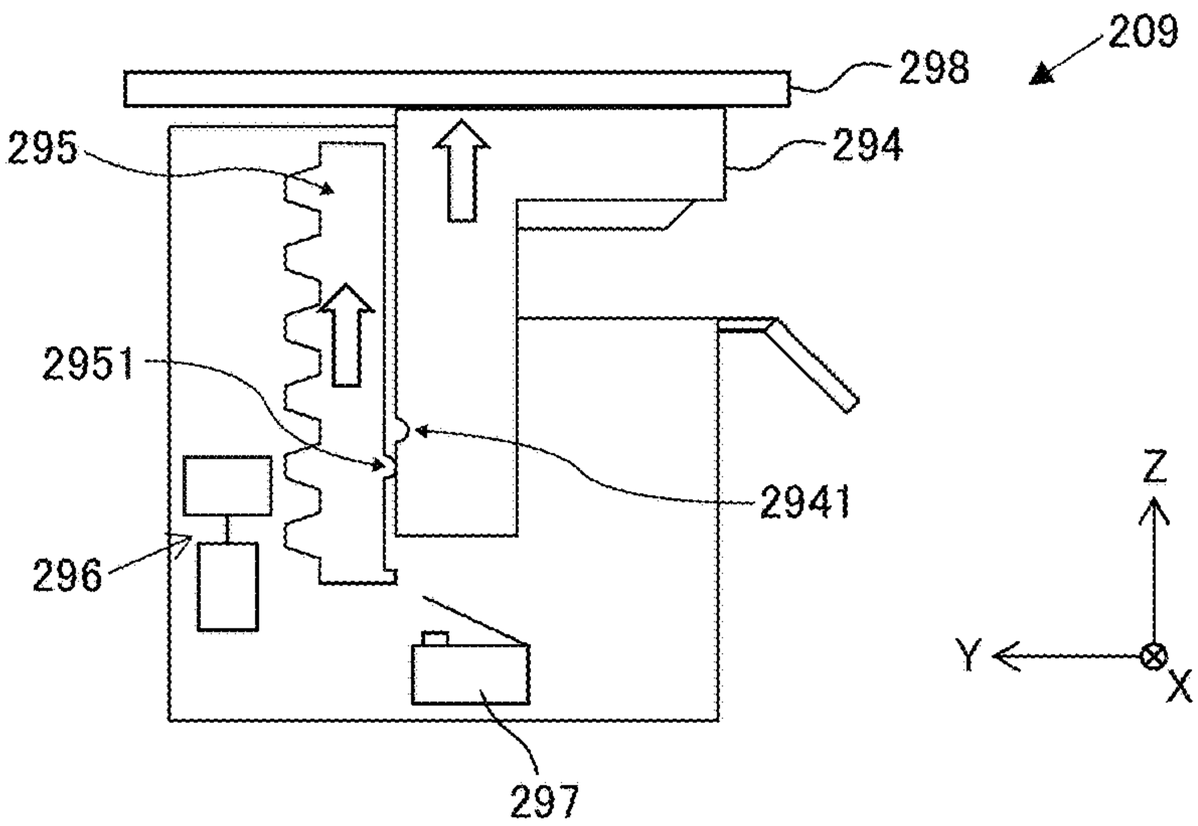


FIG. 11C

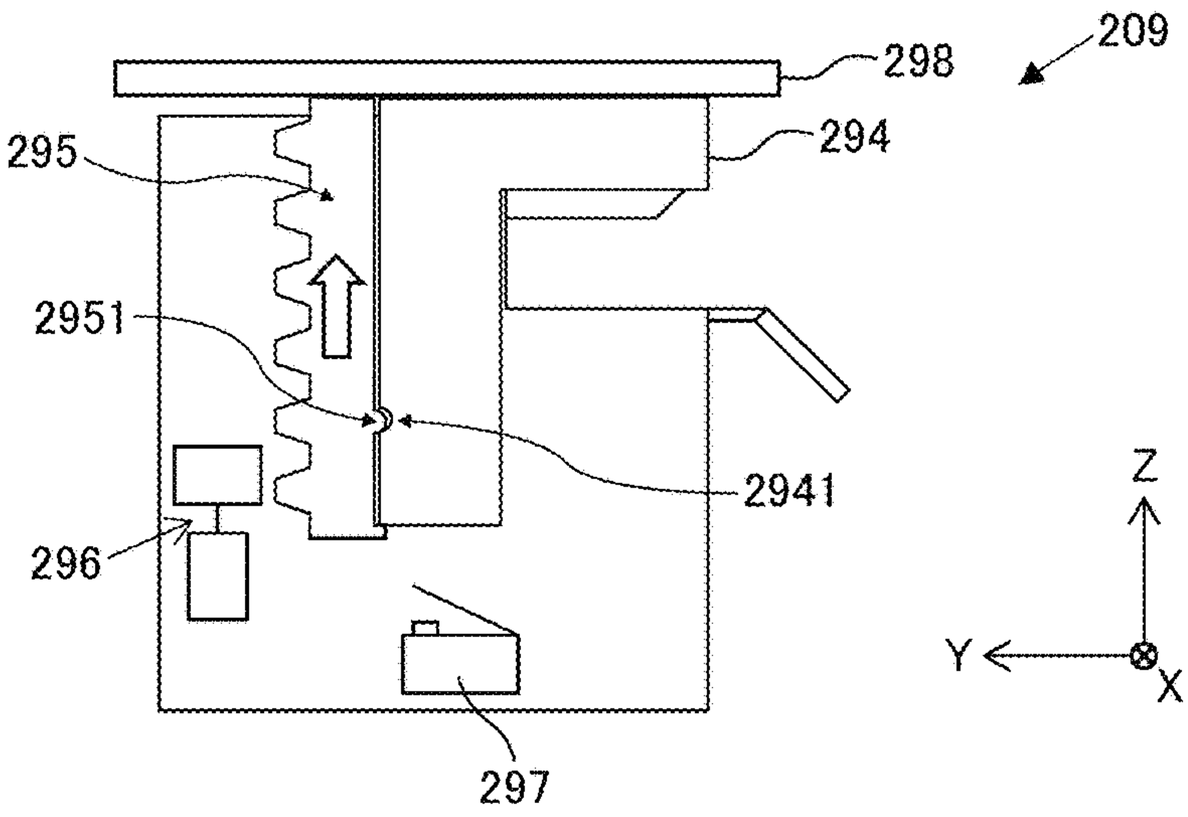


FIG. 12A

FIG. 12 | FIG. 12A / FIG. 12B

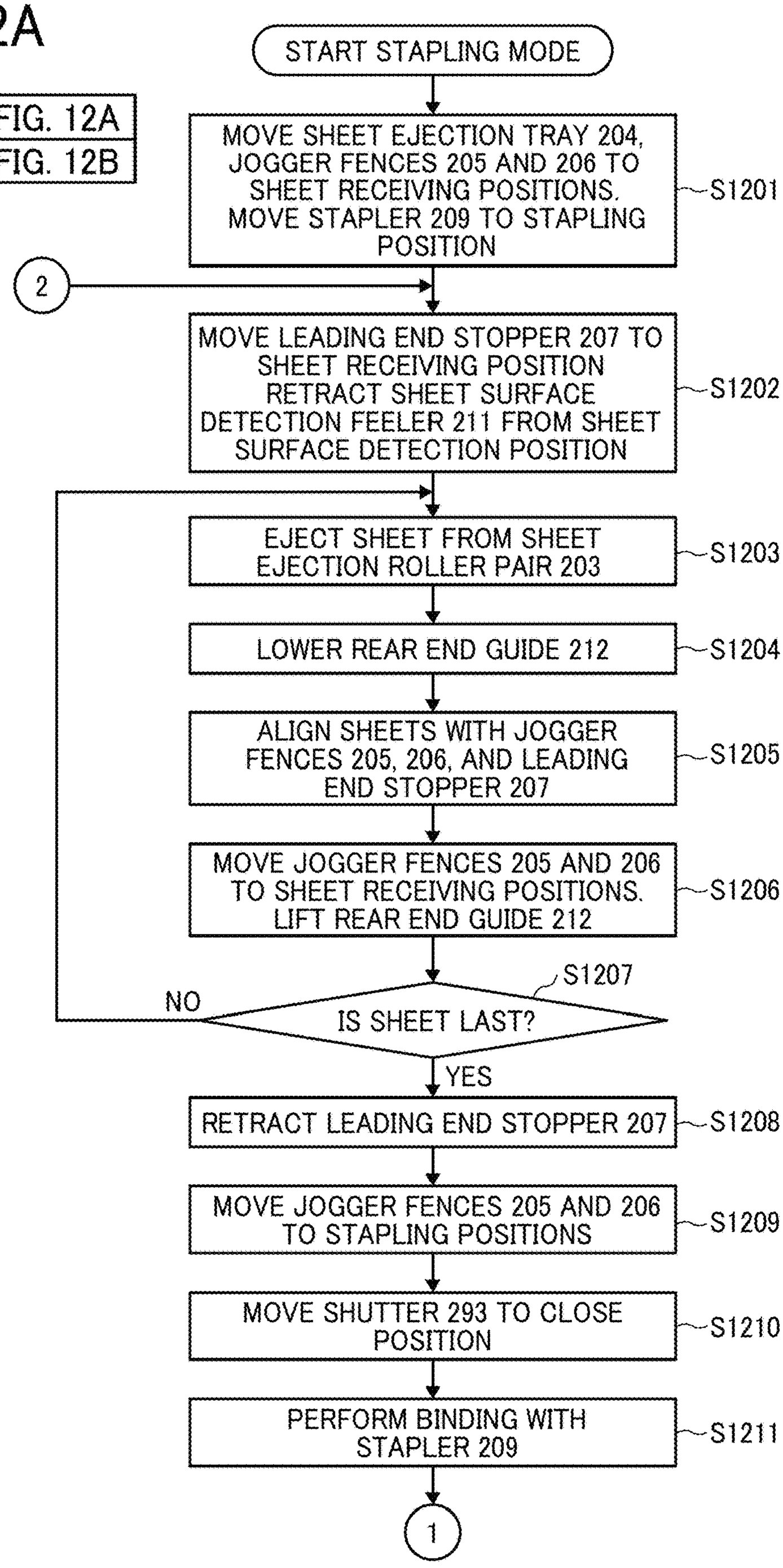


FIG. 12B

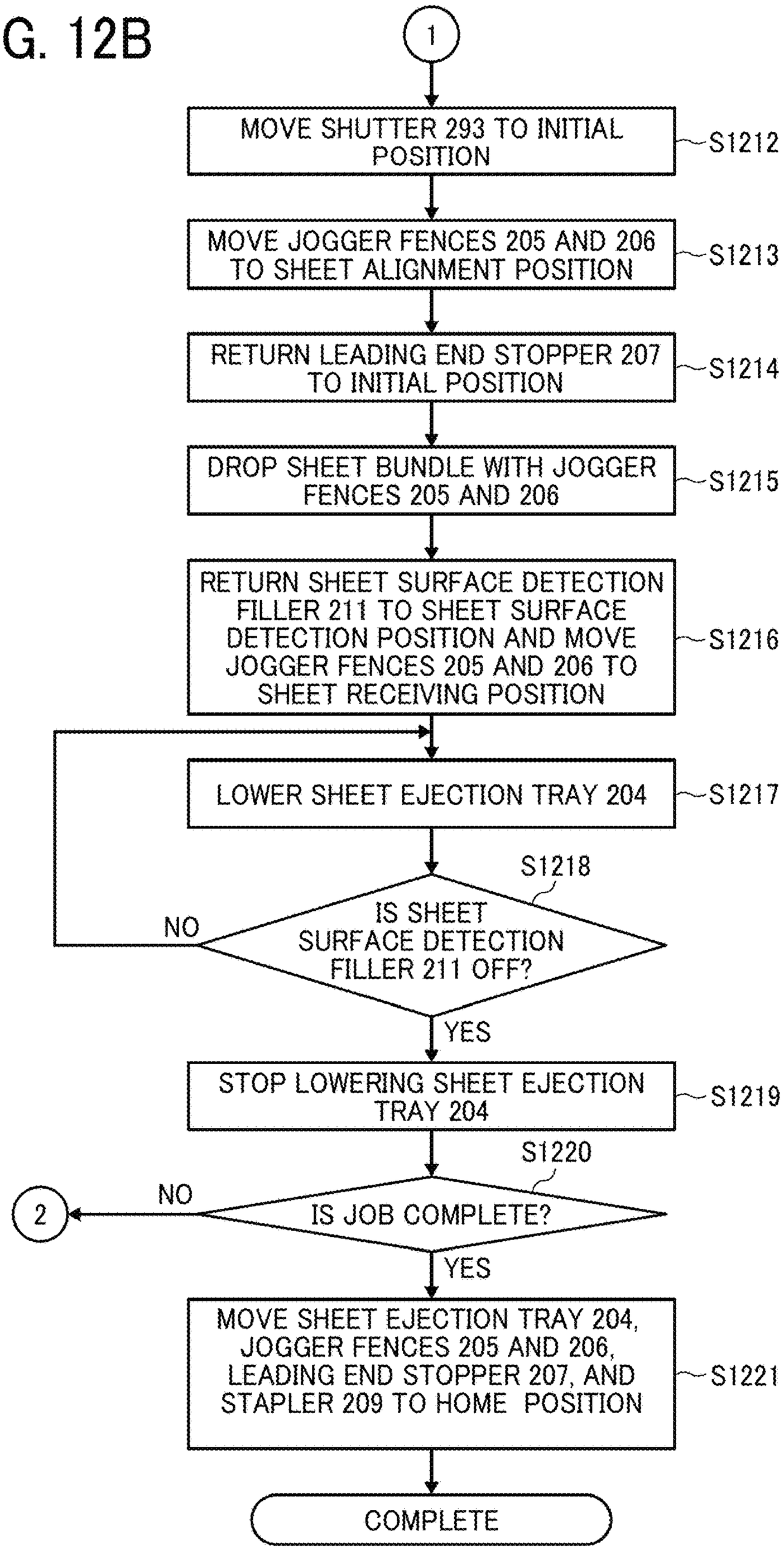

1
MOVE SHUTTER 293 TO INITIAL POSITION
S1212
MOVE JOGGER FENCES 205 AND 206 TO SHEET ALIGNMENT POSITION
S1213
RETURN LEADING END STOPPER 207 TO INITIAL POSITION
S1214
DROP SHEET BUNDLE WITH JOGGER FENCES 205 AND 206
S1215
RETURN SHEET SURFACE DETECTION FILLER 211 TO SHEET SURFACE DETECTION POSITION AND MOVE JOGGER FENCES 205 AND 206 TO SHEET RECEIVING POSITION
S1216
LOWER SHEET EJECTION TRAY 204
S1217
S1218
IS SHEET SURFACE DETECTION FILLER 211 OFF?
NO
YES
STOP LOWERING SHEET EJECTION TRAY 204
S1219
S1220
IS JOB COMPLETE?
NO
2
YES
MOVE SHEET EJECTION TRAY 204, JOGGER FENCES 205 AND 206, LEADING END STOPPER 207, AND STAPLER 209 TO HOME POSITION
S1221
COMPLETE

FIG. 13A

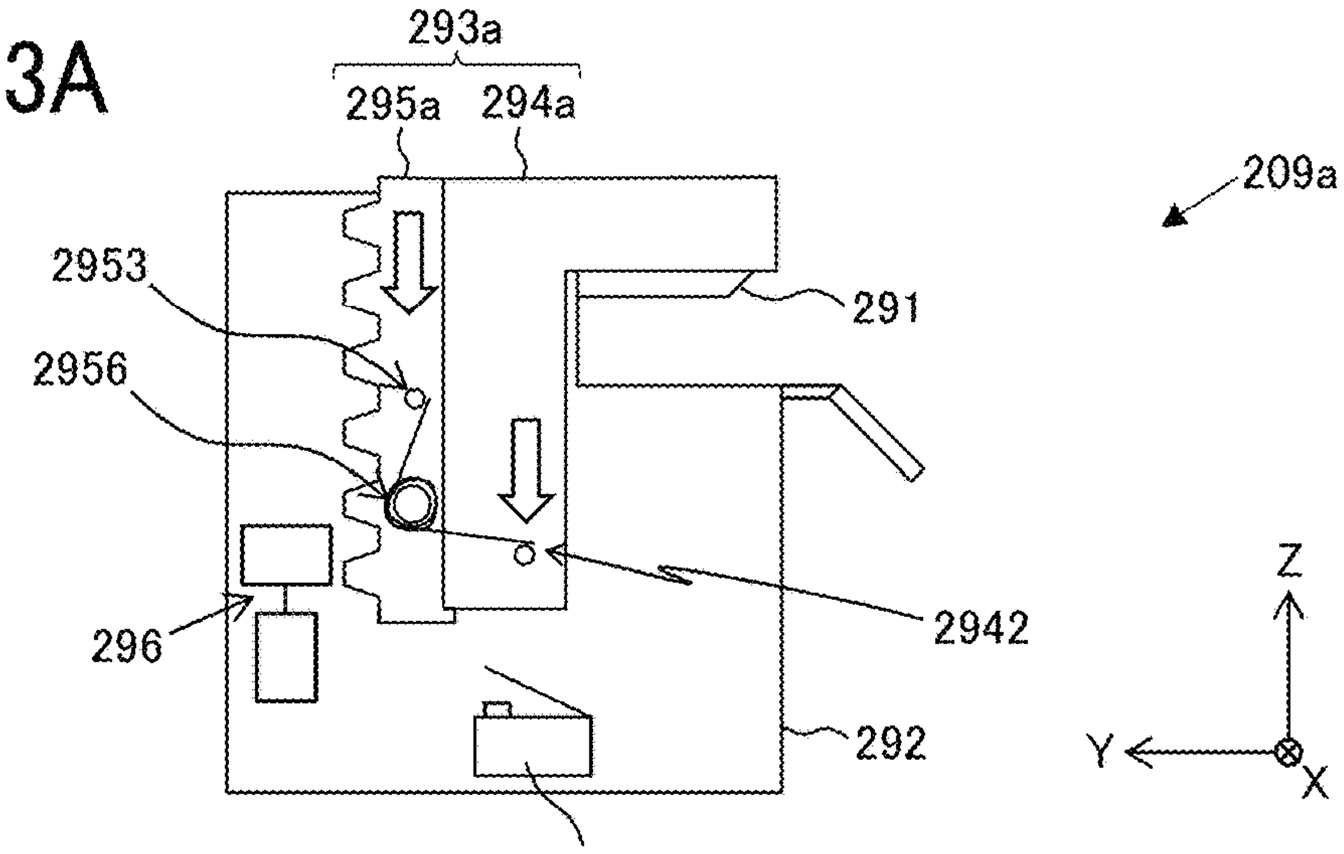


FIG. 13B

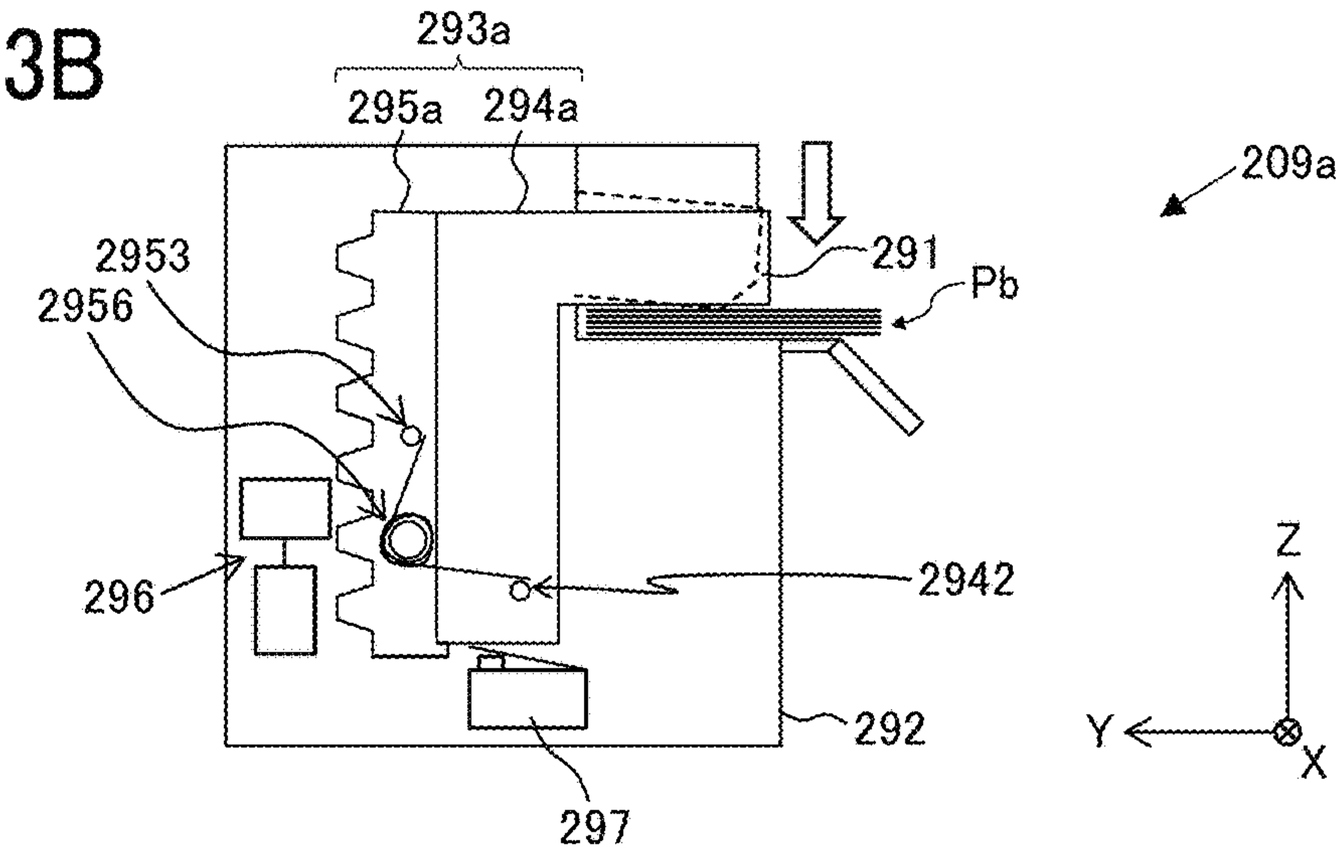


FIG. 13C

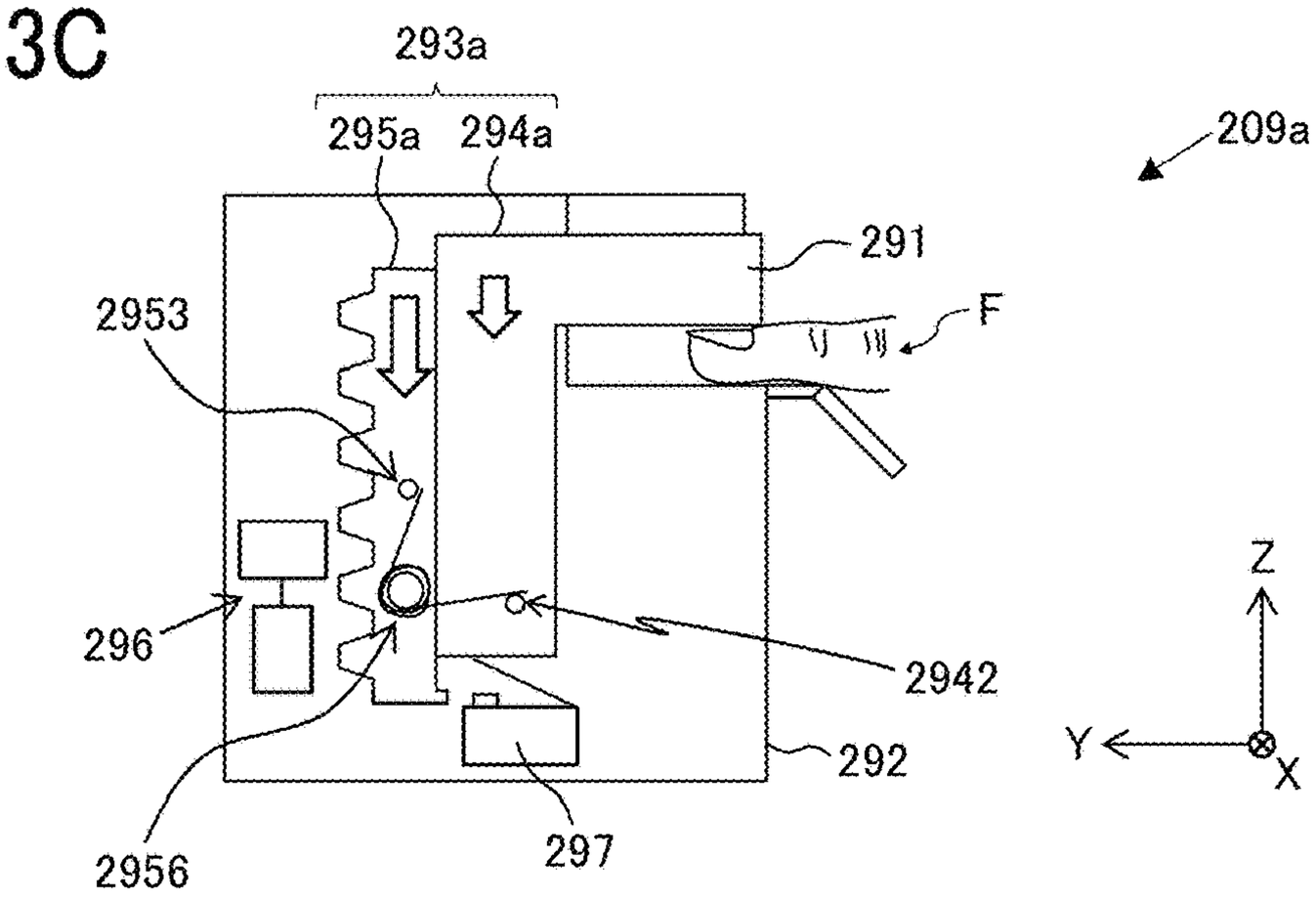


FIG. 14A

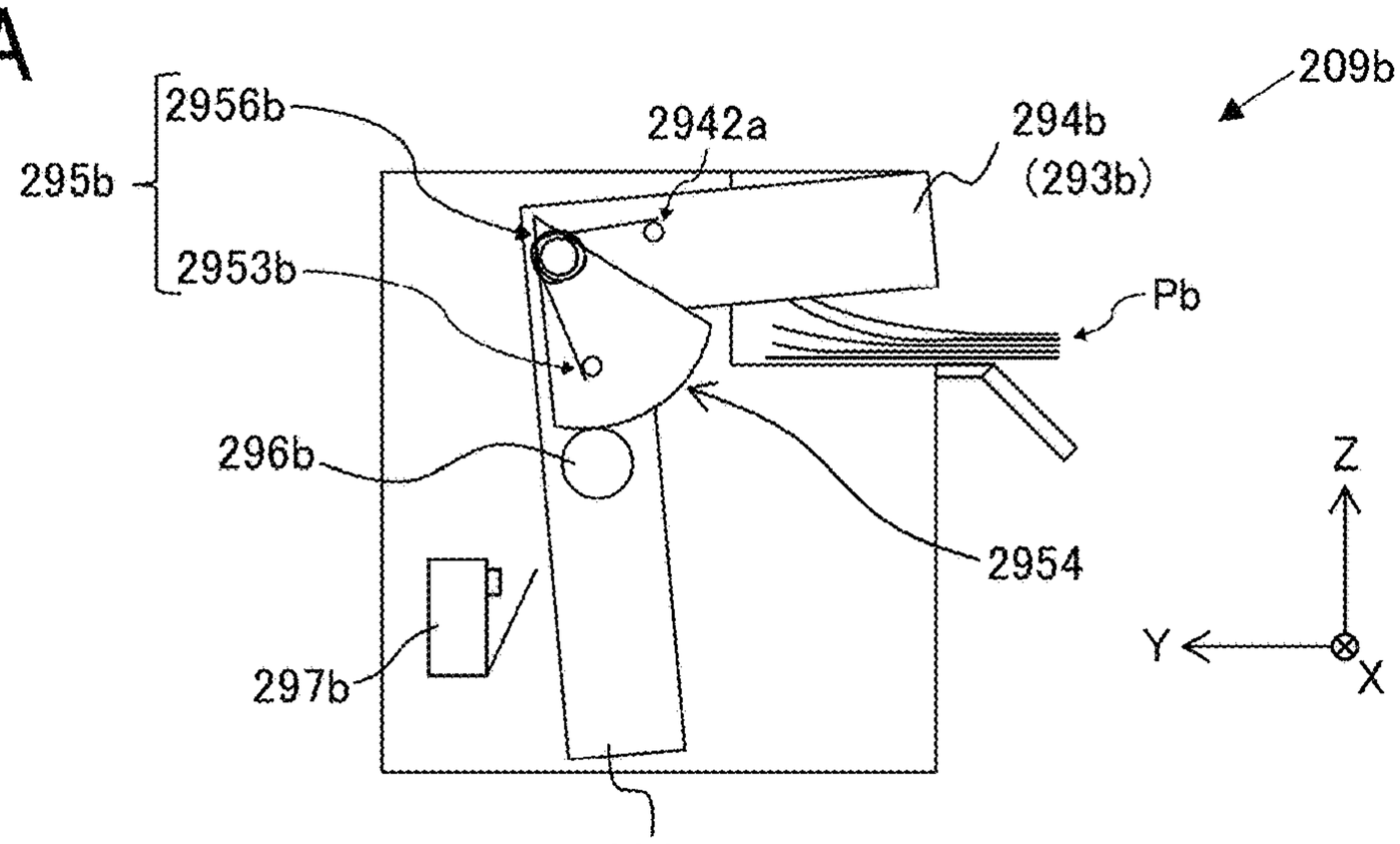


FIG. 14B

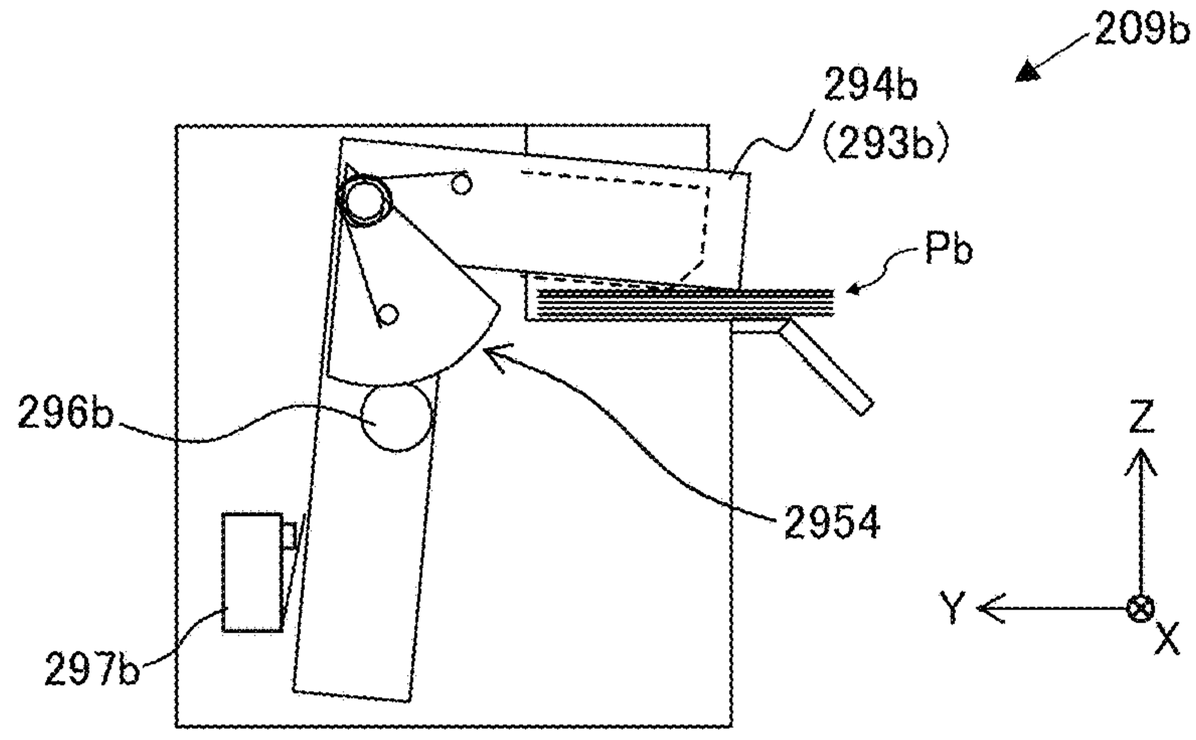


FIG. 14C

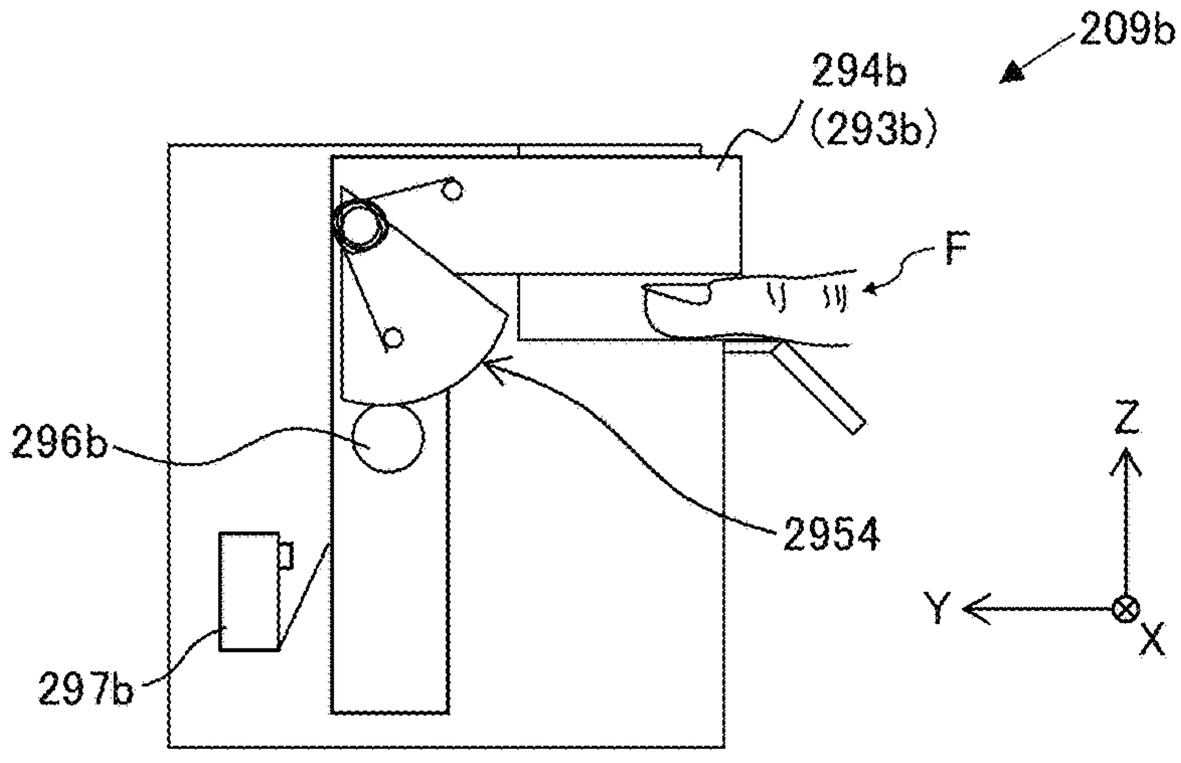


FIG. 15A

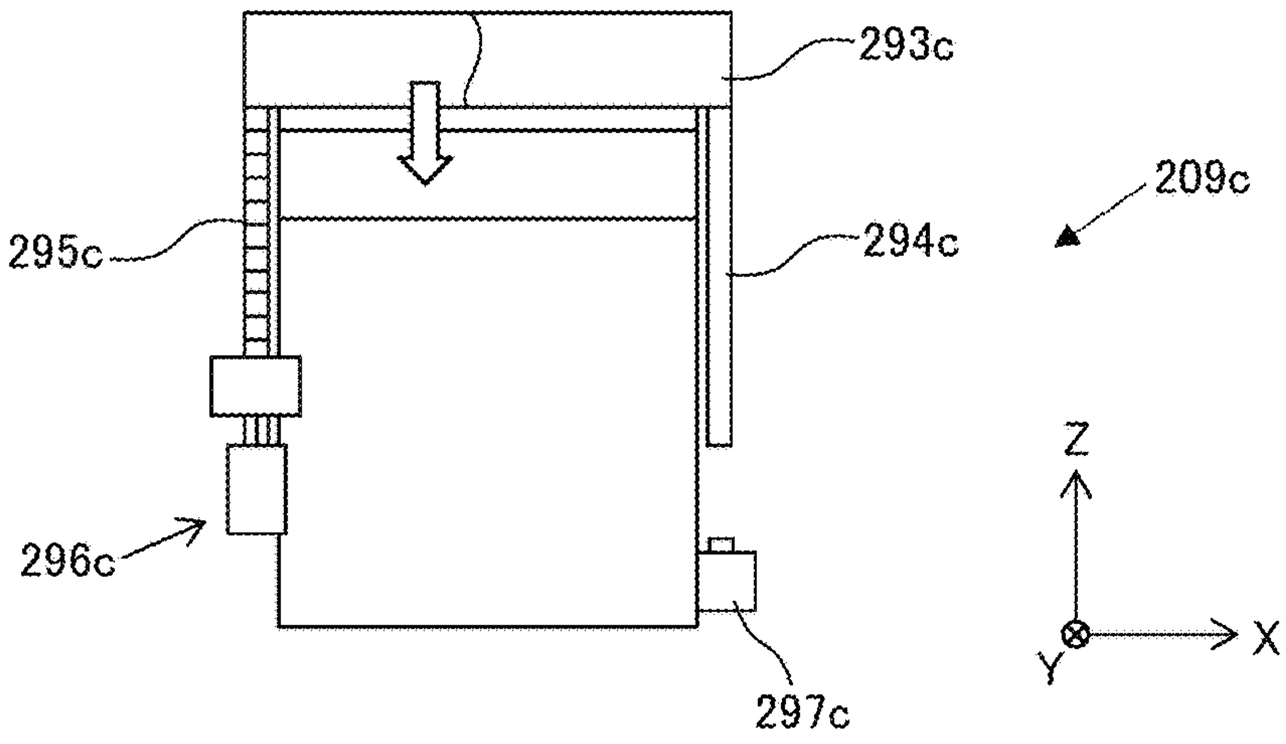


FIG. 15B

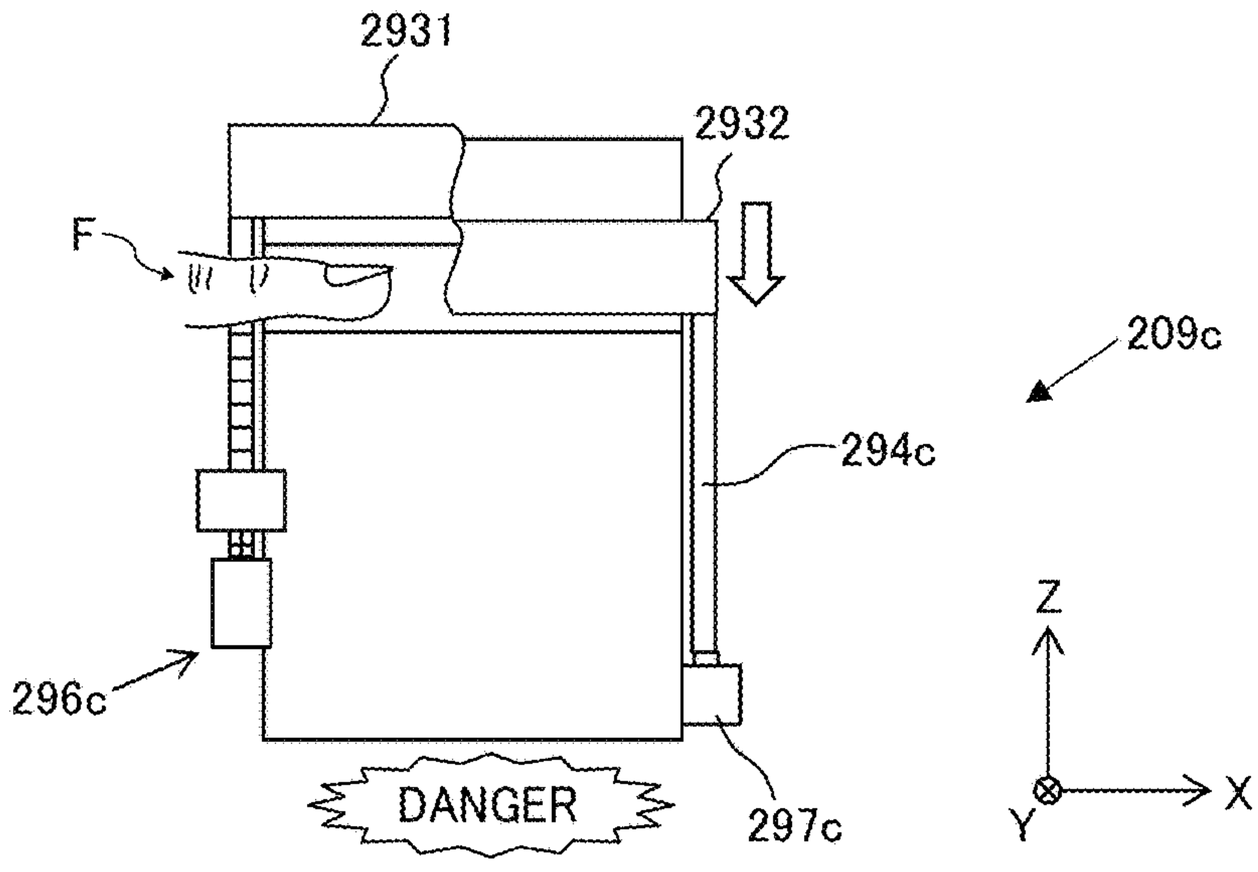


FIG. 15C

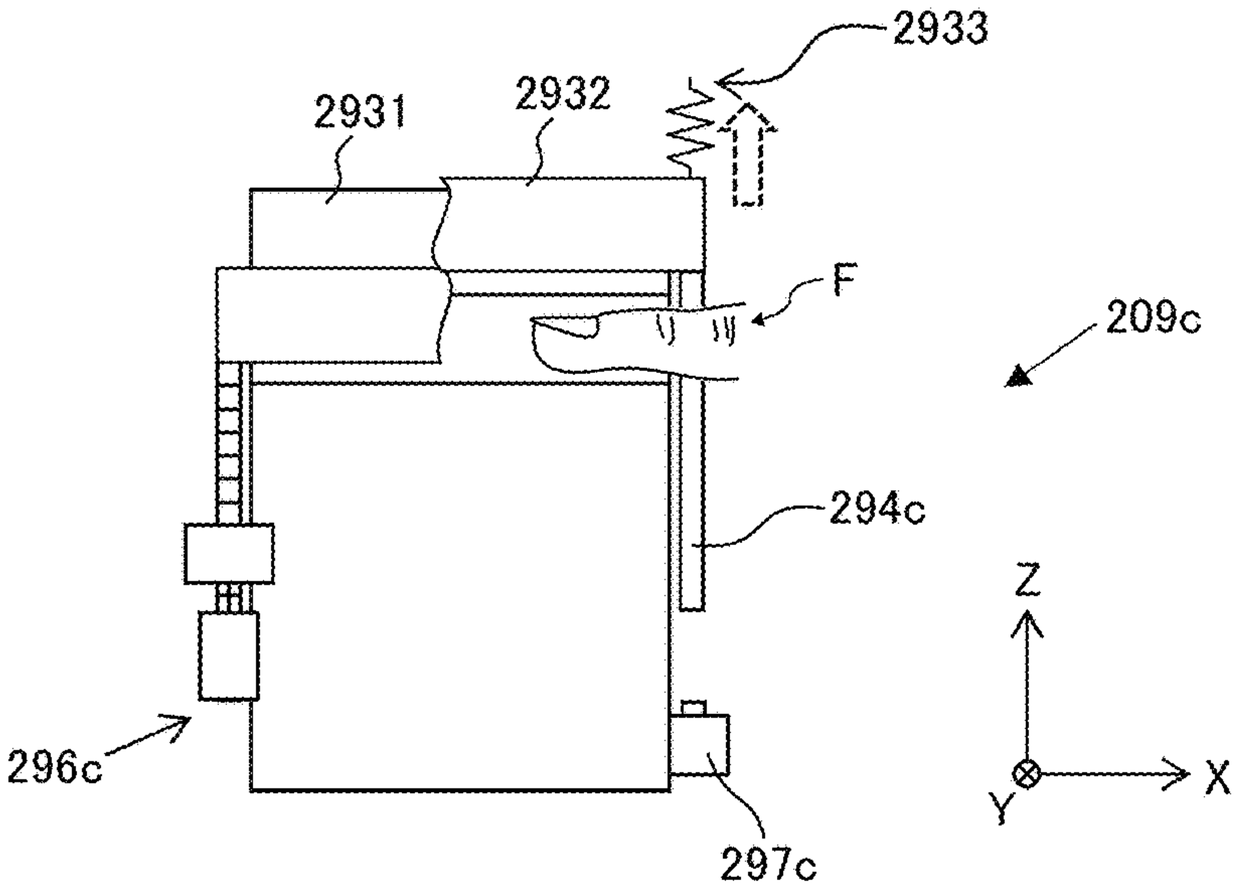


FIG. 16A

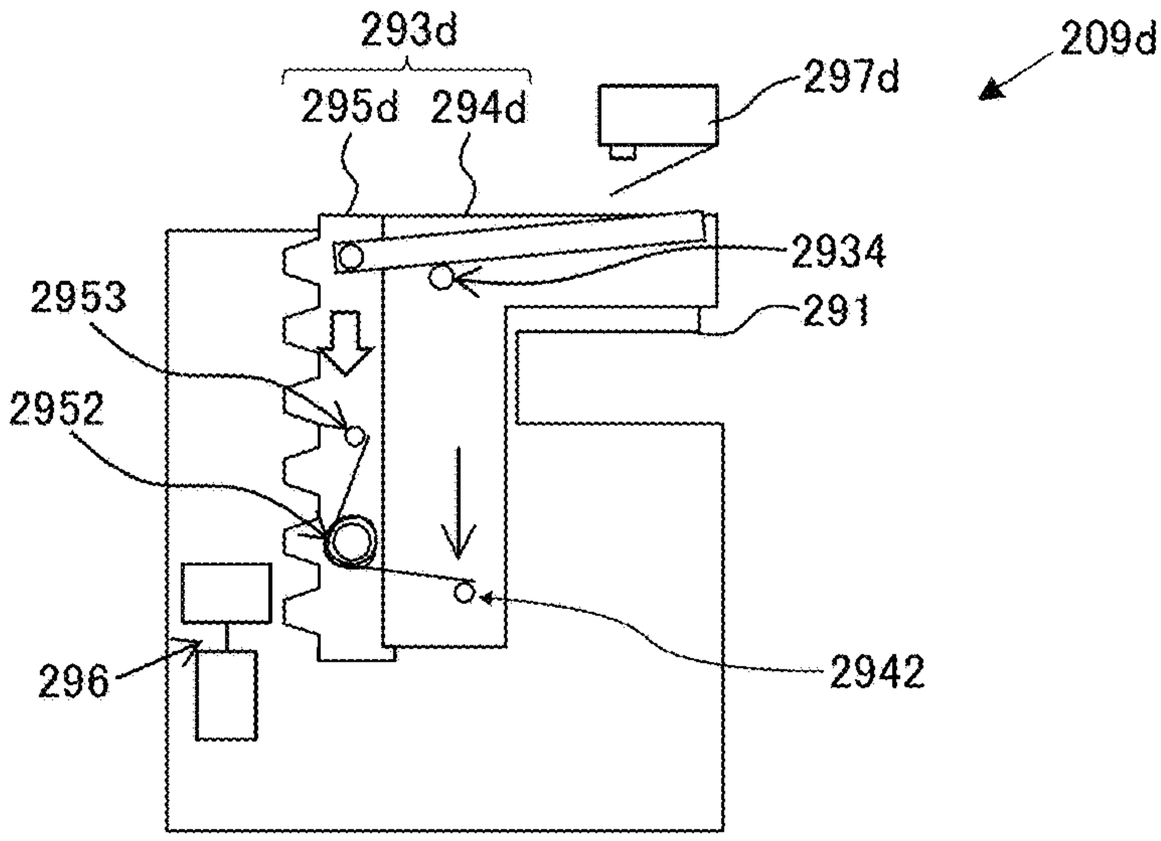


FIG. 16B

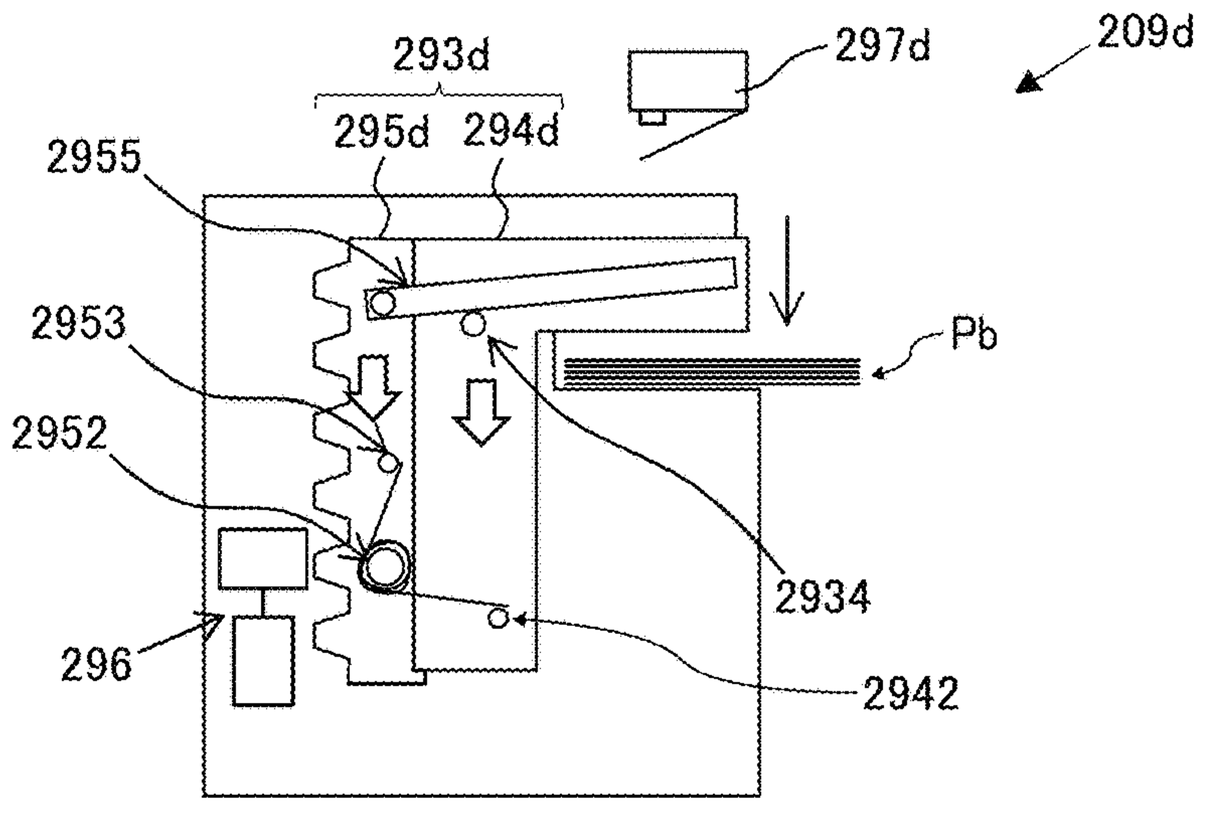


FIG. 16C

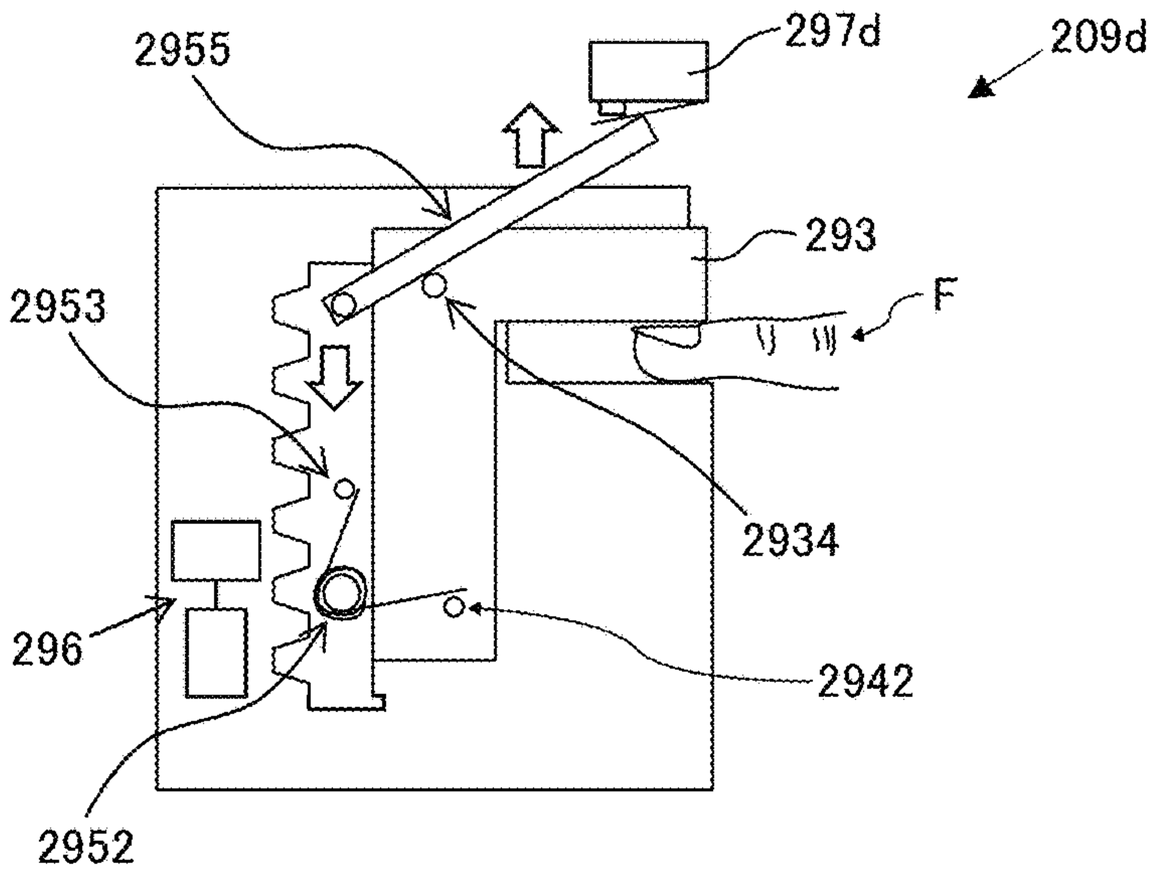


FIG. 17A

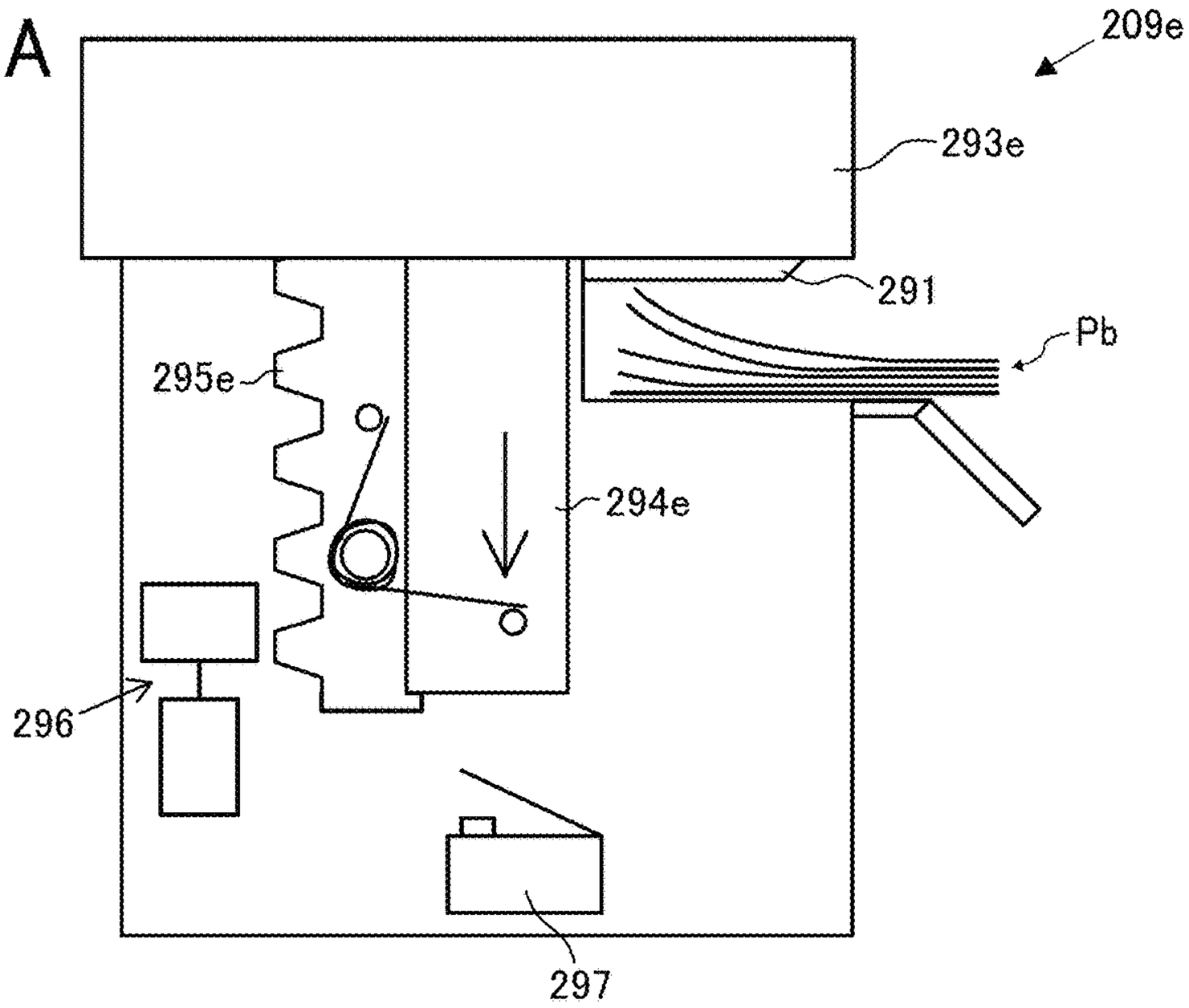


FIG. 17B

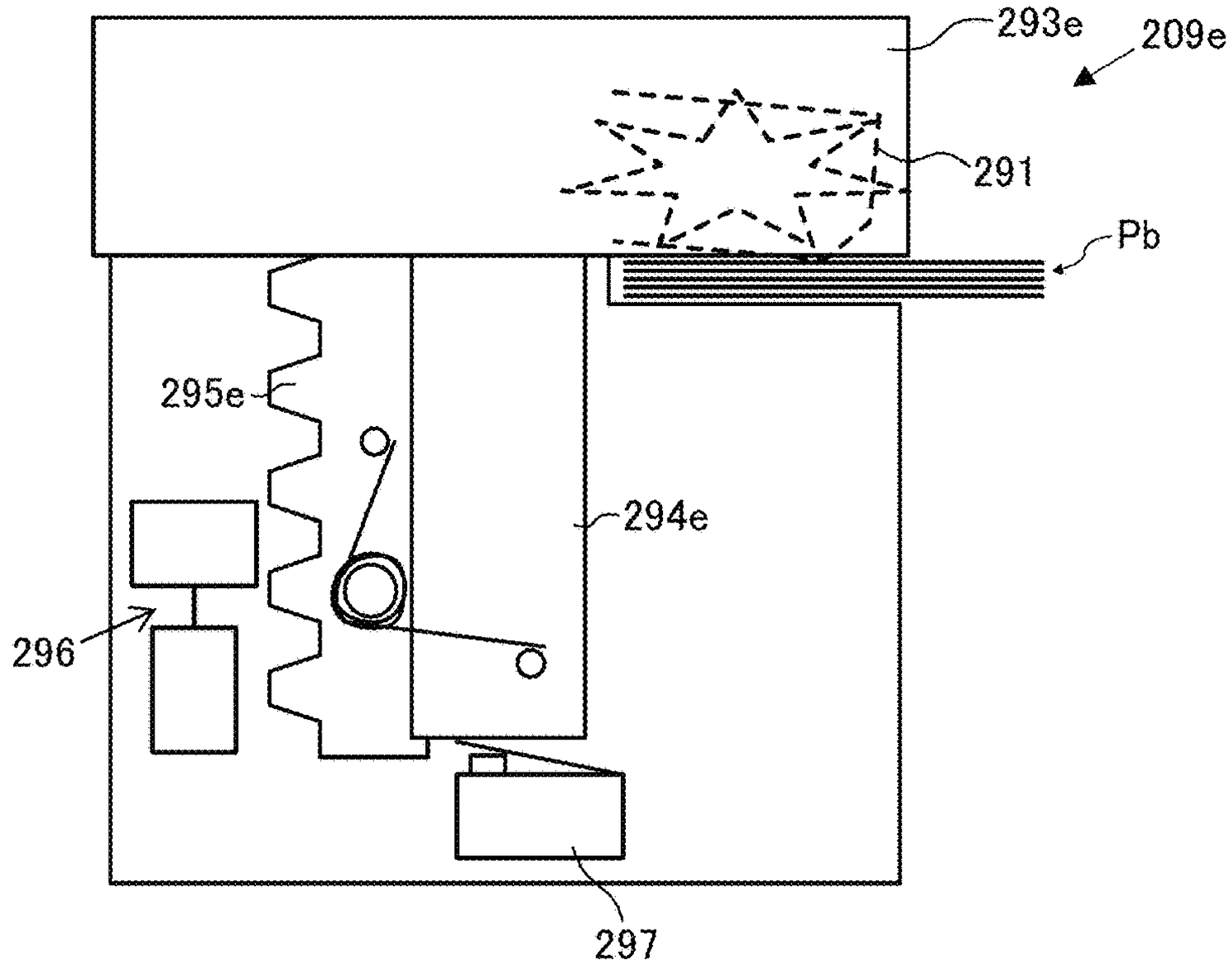


FIG. 18A

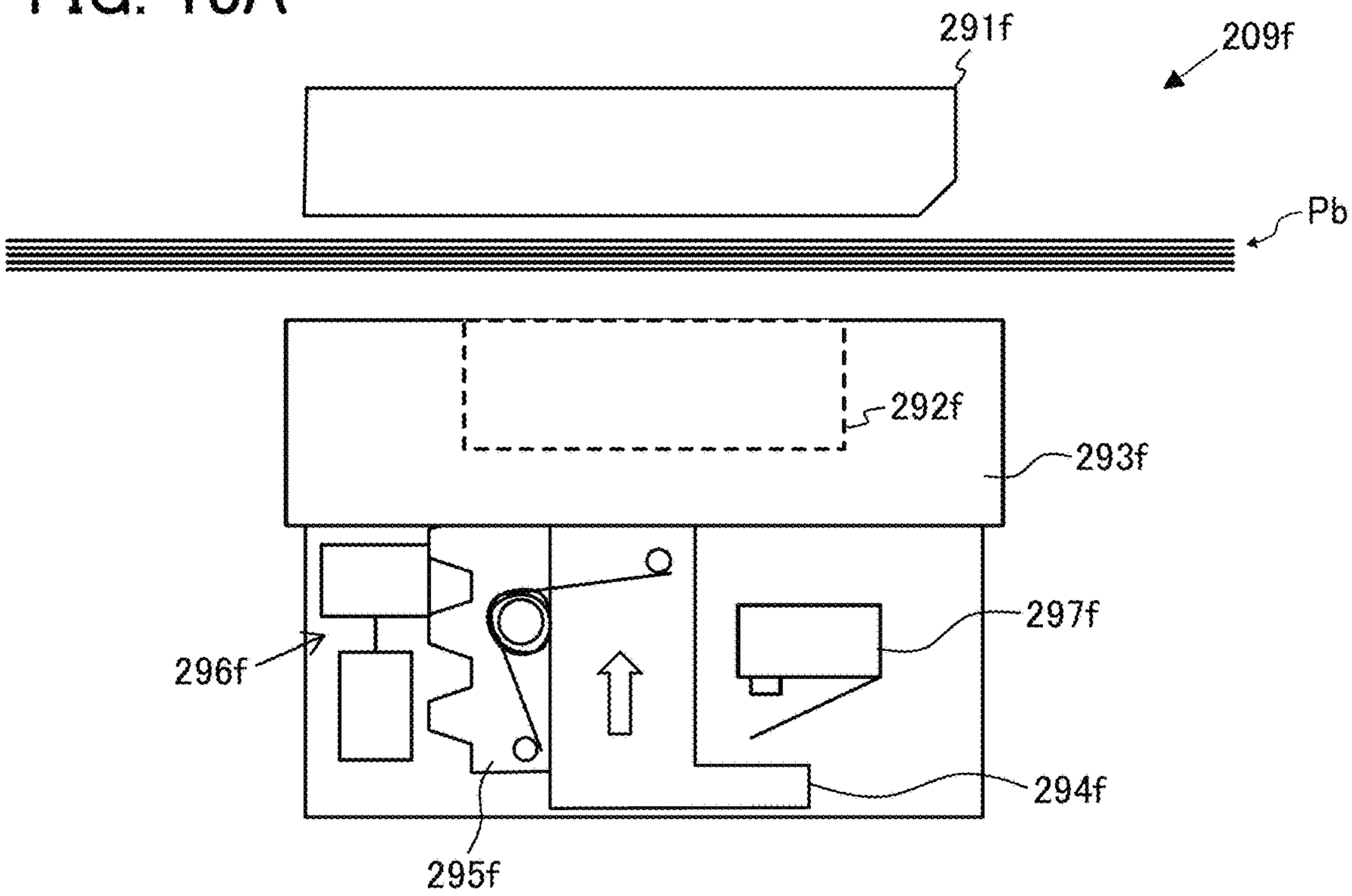


FIG. 18B

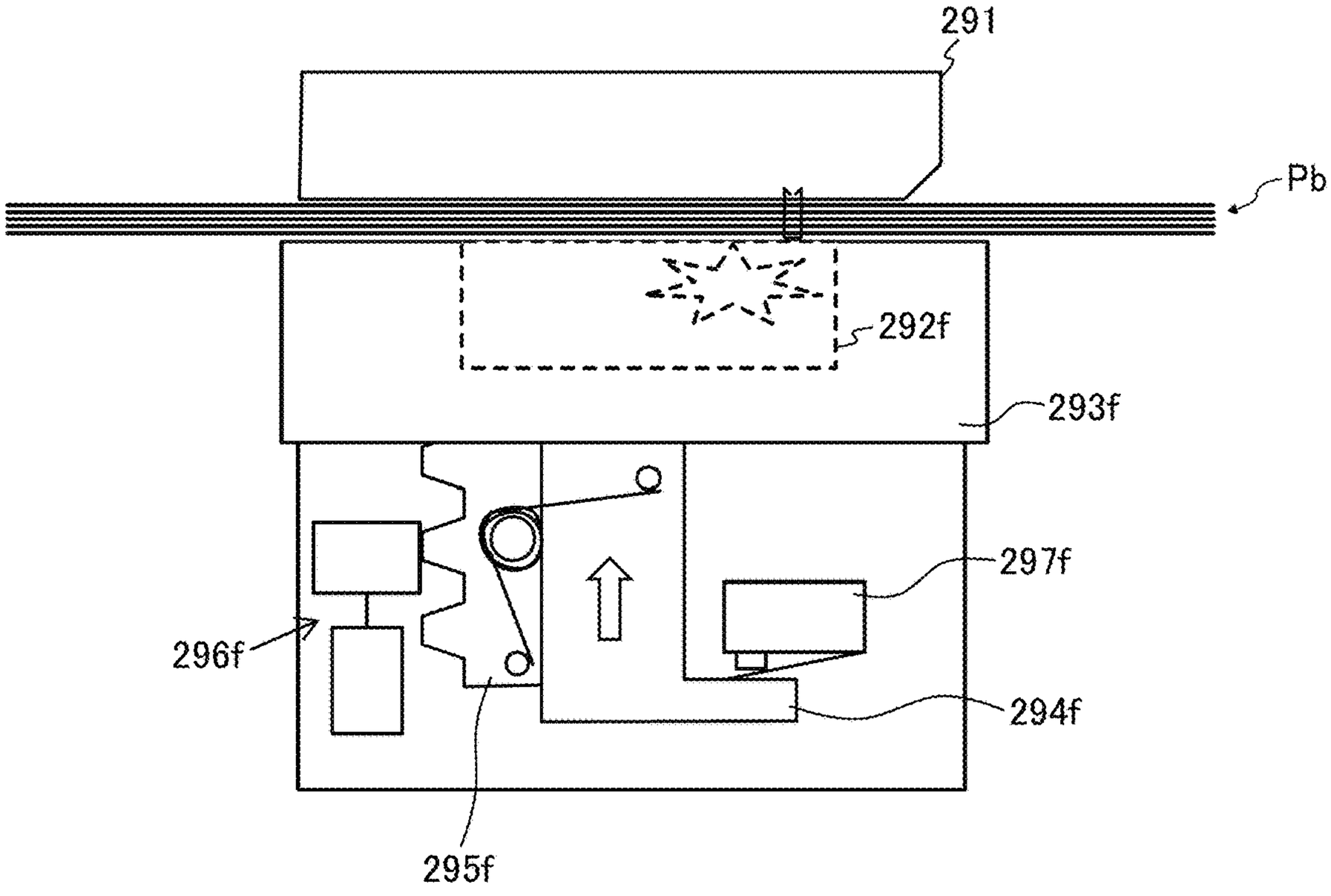


FIG. 19

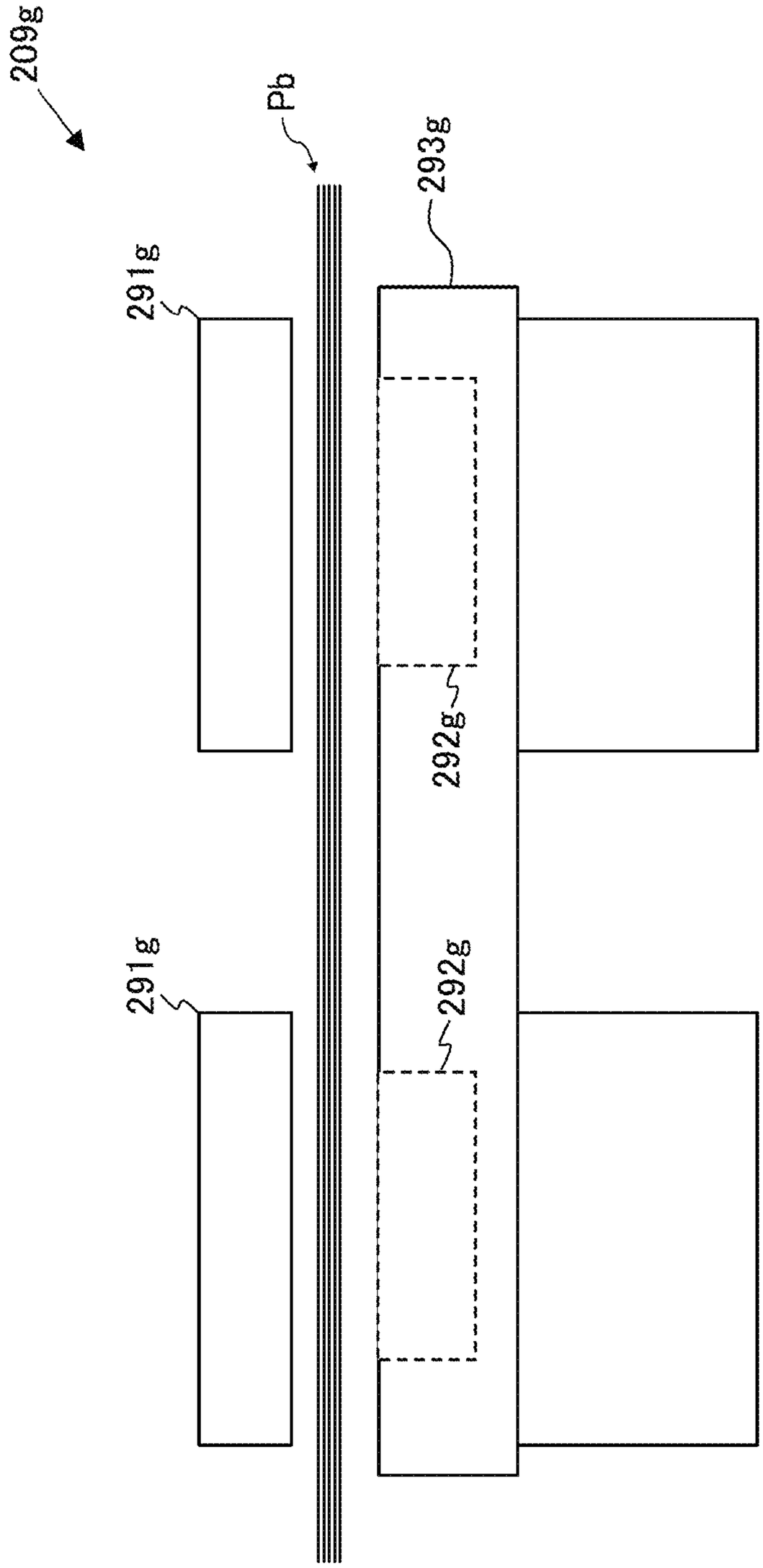


FIG. 20

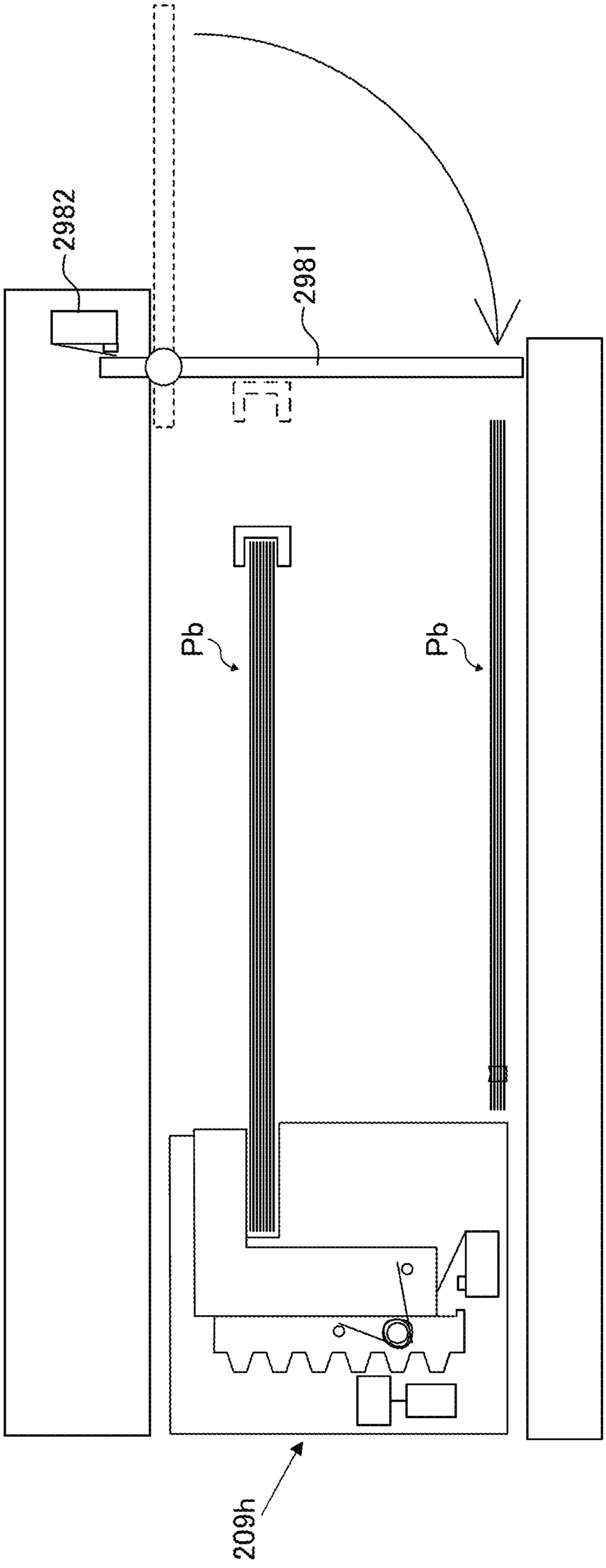
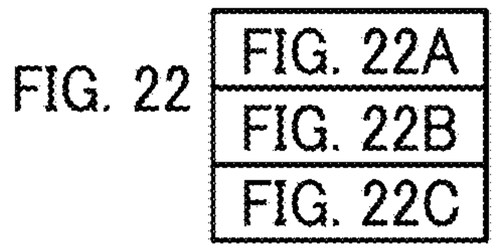


FIG. 21

State of changeover switch 297	State of protection switch 2982	Power supply to stapler 209h	Status description
0: The gap between the shutter 293 and driver unit 292 is wider than the thickness of predetermined number of sheets to be bound.	0: Protection cover 2981 is open.	0: Power supply is off.	When the gap between the driver unit 292 and the clincher 291 is large and the protection cover 2981 is not closed, power is not supplied to the stapler 209h.
0: The gap between the shutter 293 and driver unit 292 is wider than the thickness of predetermined number of sheets to be bound.	1: Protection cover 2981 is closed.	1: Power supply is on.	The gap between the the driver unit 292 and the clincher 291 is large. However, the protection cover 2981 is closed and no foreign matter has entered. Accordingly, power is supplied to the stapler 209h.
1: The gap between the shutter 293 and driver unit 292 is smaller than the thickness of predetermined number of sheets to be bound.	1: Protection cover 2981 is closed.	1: Power supply is on.	The gap between the the driver unit 292 and the clincher 291 is small. The protection cover 2981 is closed and no foreign matter has entered. Accordingly, power is supplied to the stapler 209h.
1: The gap between the shutter 293 and driver unit 292 is smaller than the thickness of predetermined number of sheets to be bound.	0: Protection cover 2981 is open.	1: Power supply is on.	The gap between the the driver unit 292 and the clincher 291 is small and the protection cover 2981 is open. However, no foreign matter has entered and safety is ensured. Accordingly, power is supplied to the stapler 209h.

FIG. 22A

FIG. 22



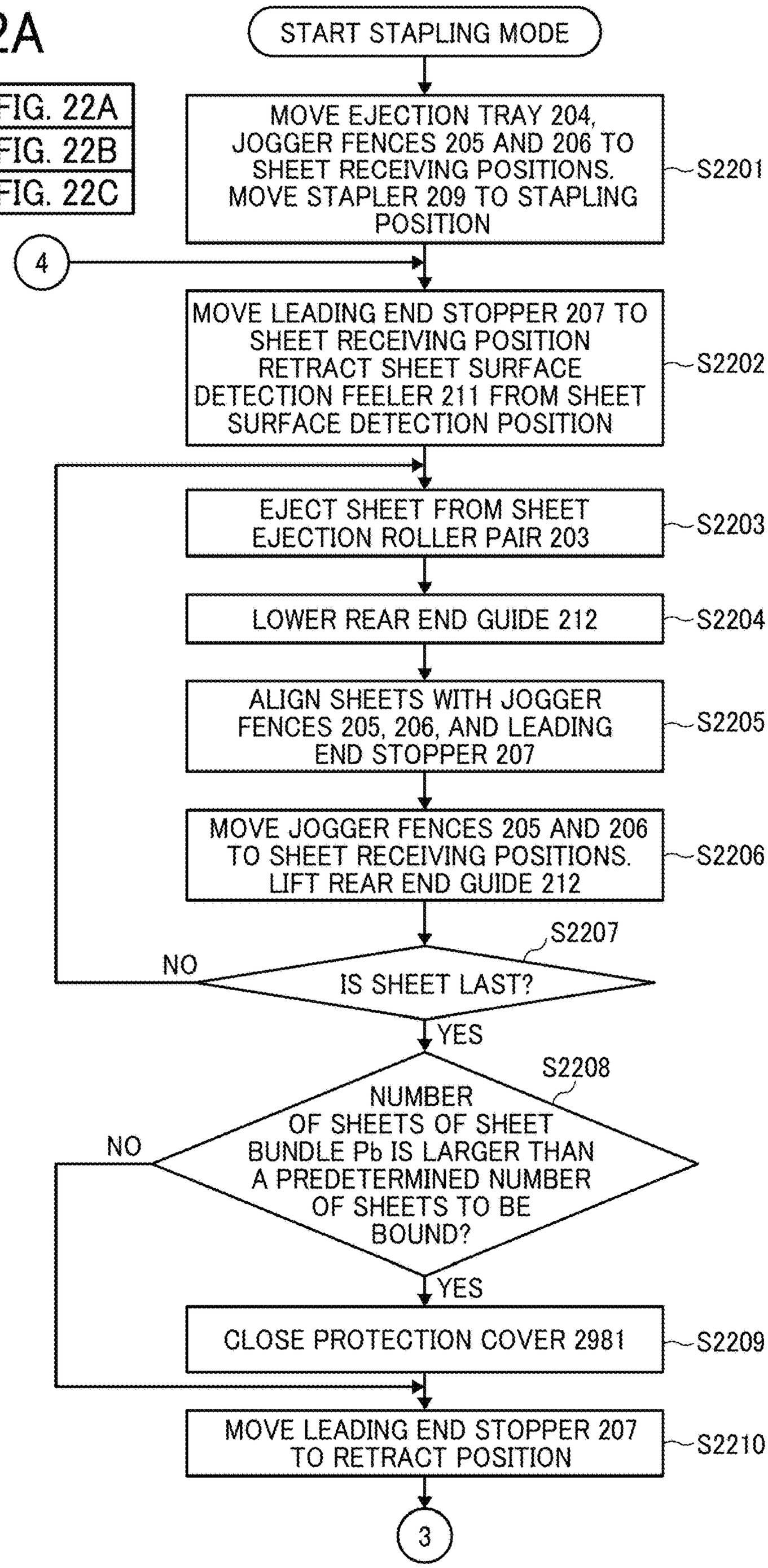


FIG. 22B

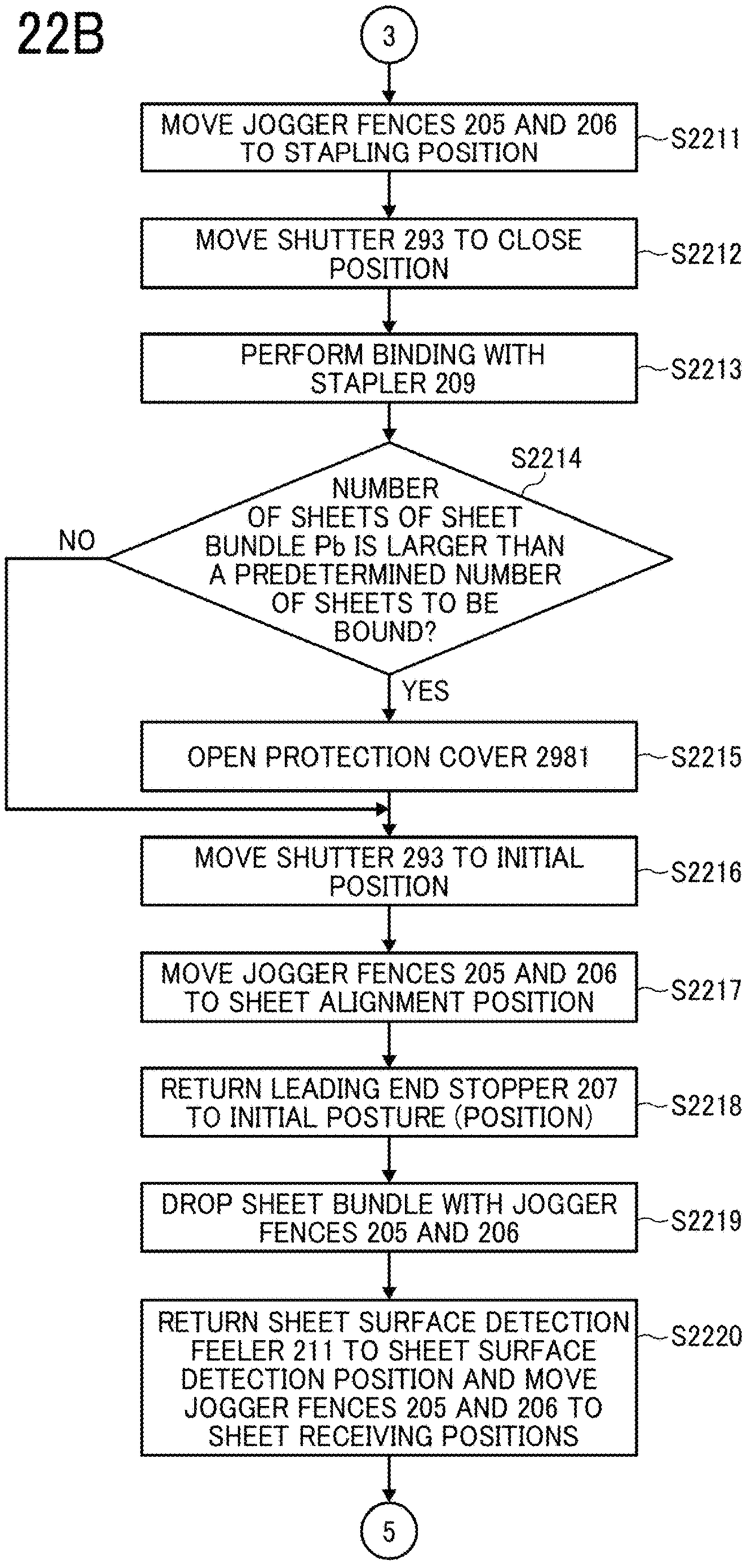
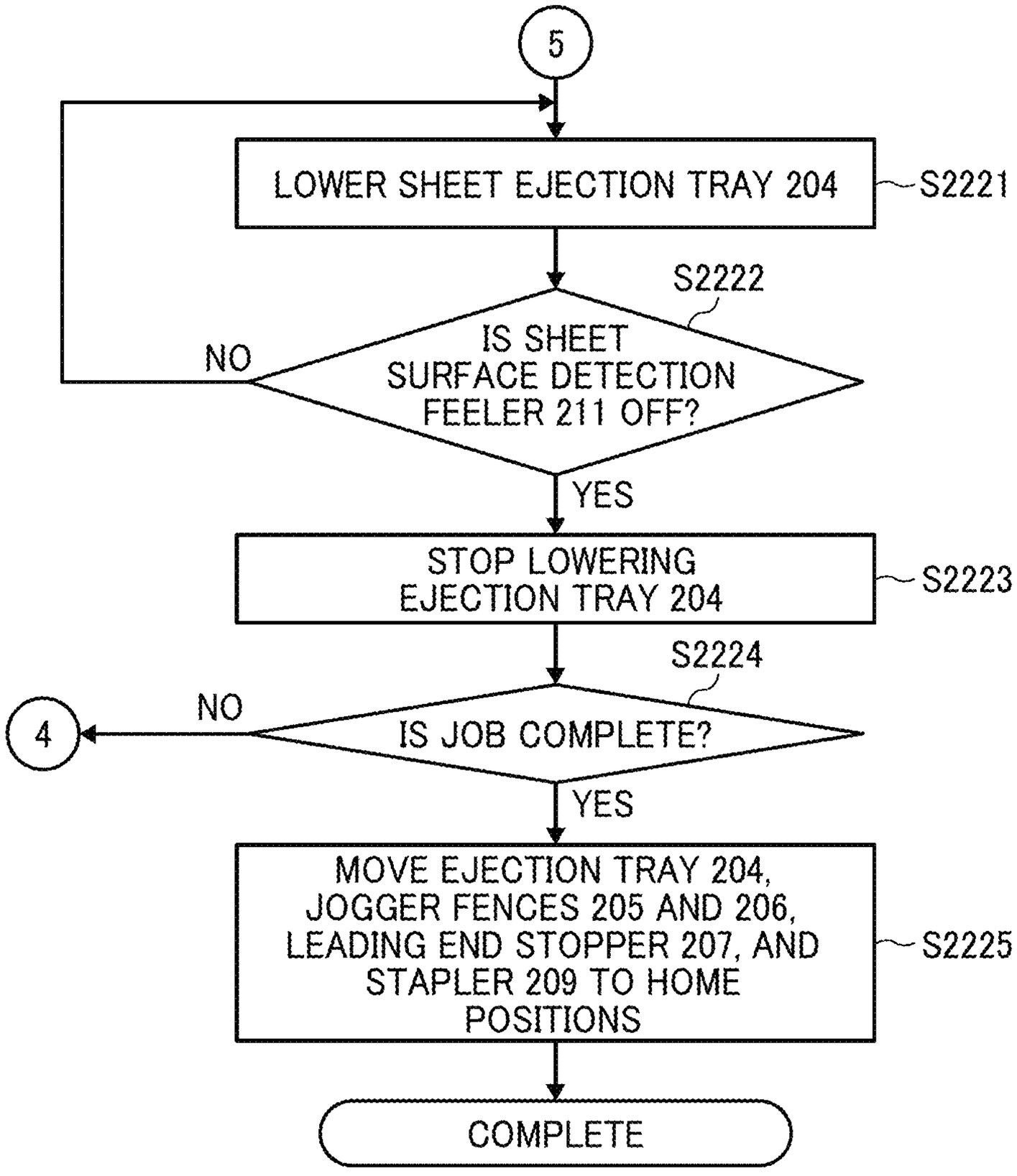

3
MOVE JOGGER FENCES 205 AND 206 TO STAPLING POSITION
S2211
MOVE SHUTTER 293 TO CLOSE POSITION
S2212
PERFORM BINDING WITH STAPLER 209
S2213
S2214
NUMBER OF SHEETS OF SHEET BUNDLE Pb IS LARGER THAN A PREDETERMINED NUMBER OF SHEETS TO BE BOUND?
NO
YES
OPEN PROTECTION COVER 2981
S2215
MOVE SHUTTER 293 TO INITIAL POSITION
S2216
MOVE JOGGER FENCES 205 AND 206 TO SHEET ALIGNMENT POSITION
S2217
RETURN LEADING END STOPPER 207 TO INITIAL POSTURE (POSITION)
S2218
DROP SHEET BUNDLE WITH JOGGER FENCES 205 AND 206
S2219
RETURN SHEET SURFACE DETECTION FEELER 211 TO SHEET SURFACE DETECTION POSITION AND MOVE JOGGER FENCES 205 AND 206 TO SHEET RECEIVING POSITIONS
S2220
5

FIG. 22C


5
LOWER SHEET EJECTION TRAY 204
S2221
S2222
IS SHEET SURFACE DETECTION FEELER 211 OFF?
NO
YES
STOP LOWERING EJECTION TRAY 204
S2223
S2224
IS JOB COMPLETE?
NO
4
YES
MOVE EJECTION TRAY 204, JOGGER FENCES 205 AND 206, LEADING END STOPPER 207, AND STAPLER 209 TO HOME POSITIONS
S2225
COMPLETE

POST PROCESSING APPARATUS AND IMAGE FORMING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATION

This patent application is based on and claims priority pursuant to 35 U.S.C. § 119(a) to Japanese Patent Application No. 2020-079463, filed on Apr. 28, 2020, in the Japan Patent Office, the entire disclosure of which is hereby incorporated by reference herein.

BACKGROUND

Technical Field

Embodiments of the present disclosure relate to a post processing apparatus, and an image forming system.

Description of the Related Art

There is known an image forming apparatus that forms an image on a sheet. A post-processing apparatus that performs a sheet aligning function for aligning end portions of sheets and binding on a bundle of aligned sheets are also known. There is also known an image forming system that includes an image forming apparatus and a post-processing apparatus and binds and ejects a bundle of sheets on which images have been formed.

There is also known a conventional post-processing apparatus includes a shutter mechanism that prevents an object (foreign object), which is different from a sheet bundle as a target for the binding process, from entering the binding space (processing region) of a stapler. Some conventional shutter mechanisms include a sensor that detects the presence or absence of a foreign object in a processing region.

There is known a technology in which a shutter that covers a vicinity of a binding unit is provided, and a sensor detects a difference in thickness between a sheet bundle and a foreign object, thereby preventing entry of the foreign object thicker than the sheet bundle even when the sheet bundle is removed from the binding unit.

SUMMARY

In an aspect of the present disclosure, a post-processing apparatus includes a binding device, a closing device, a driver, and a changeover switch. The binding device is configured to bind a sheet bundle. The closing device is configured to close an entrance to a binding position at which the binding device binds the sheet bundle. The driver is configured to move the closing device to a closing position at which the closing device closes the entrance. The changeover switch is configured to perform switching to implement a state in which the binding device is able to bind the sheet bundle when the closing device moves to the closing position. The closing device includes an avoidance operation portion configured to move to the closing position to operate the changeover switch, and a drive coupler coupled to the avoidance operation device to move the avoidance operation portion to the closing position by a driving force caused by the driver. A coupling state between the avoidance operation portion and the drive coupler is released when movement of the avoidance operation portion to the closing position is prevented.

In another aspect of the present disclosure, an image forming system includes an image forming apparatus and the post-processing apparatus. The image forming apparatus is configured to form an image on a sheet. The post-processing apparatus is configured to bind a sheet bundle of sheets on which images have been formed by the image forming apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete appreciation of the disclosure and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1** is a schematic diagram of a configuration of an image forming system according to an embodiment of the present disclosure;

FIG. **2** is a schematic top view of a post-processing apparatus according to an embodiment of the present disclosure;

FIG. **3** is a schematic side view of a post-processing apparatus according to an embodiment of the present disclosure;

FIG. **4** is a schematic side view of a post-processing apparatus at the time when the operations in a stapling mode are performed according to a first embodiment of the present disclosure;

FIG. **5** is a schematic top view of a post-processing apparatus at the time when the operations in a stapling mode are performed according to the first embodiment of the present disclosure;

FIG. **6** is another schematic top view of a post-processing apparatus at the time when the operations in a stapling mode are performed according to the first embodiment of the present disclosure;

FIG. **7** is a schematic top view of a post-processing apparatus at the time when a stapler moves to a stapling position, according to the first embodiment of the present disclosure;

FIG. **8** is a schematic top view of a post-processing apparatus at the time when a bundle of sheets that have been bound is dropped according to the first embodiment of the present disclosure;

FIGS. **9**A and **9**B are diagrams each illustrating a basic configuration of a stapler of a post-processing apparatus according to the first embodiment of the present disclosure;

FIGS. **10**A, **10**B, and **10**C are diagrams each illustrating a configuration of a stapler of a post-processing apparatus according to the first embodiment of the present disclosure;

FIGS. **11**A, **11**B, and **11**C are diagrams each illustrating a configuration of a stapler of a post-processing apparatus according to the first embodiment of the present disclosure;

FIG. **12** including FIGS. **12**A and **12**B is a flowchart of a series of operations performed at a stapler in a stapling mode, according to the first embodiment of the present disclosure;

FIGS. **13**A, **13**B and **13**C are diagrams each illustrating a configuration of a stapler of a post-processing apparatus according to a second embodiment of the present disclosure;

FIGS. **14**A, **14**B, and **14**C are diagrams each illustrating a configuration of a stapler of a post-processing apparatus according to a third embodiment of the present disclosure;

FIGS. **15**A, **15**B, and **15**C are diagrams each illustrating a configuration of a stapler of a post-processing apparatus according to a fourth embodiment of the present disclosure;

FIGS. **16**A, **16**B, and **16**C are diagrams each illustrating a configuration of a stapler of a post-processing apparatus according to a fifth embodiment of the present disclosure;

FIGS. **17**A and **17**B are diagrams each illustrating a configuration of a stapler of a post-processing apparatus according to a sixth embodiment of the present disclosure;

FIGS. **18**A and **18**B are diagrams each illustrating a configuration of a stapler of a post-processing apparatus according to a seventh embodiment of the present disclosure;

FIG. **19** is a diagram illustrating a configuration of a stapler of a post-processing apparatus according to an eighth embodiment of the present disclosure;

FIG. **20** is a diagram illustrating a configuration of a stapler of a post-processing apparatus according to a ninth embodiment of the present disclosure;

FIG. **21** is a chart describing a control pattern for a stapler of a post-processing apparatus according to the ninth embodiment of the present disclosure; and

FIG. **22** including FIGS. **22**A, **22**B, and **22**C is a flowchart of a series of operations performed at a stapler in a stapling mode, according to the ninth embodiment of the present disclosure.

The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted.

DETAILED DESCRIPTION

In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this patent specification is not intended to be limited to the specific terminology so selected and it is to be understood that each specific element includes all technical equivalents that operate in a similar manner and achieve similar results.

Although the embodiments are described with technical limitations with reference to the attached drawings, such description is not intended to limit the scope of the disclosure and all of the components or elements described in the embodiments of this disclosure are not necessarily indispensable.

Referring now to the drawings, embodiments of the present disclosure are described below. In the drawings for explaining the following embodiments, the same reference codes are allocated to elements (members or components) having the same function or shape and redundant descriptions thereof are omitted below.

Hereinafter, a post-processing apparatus and an image forming system according to embodiments of the present disclosure are described with reference to the drawings. In the following descriptions, a paper medium is exemplified as an example of a sheet. However, for example, a sheet made of plastic, metal, or the like is also applicable.

Overall Configuration

FIG. **1** is a schematic diagram illustrating an image forming system **1** according to an embodiment of the present disclosure. The image forming system **1** includes an image forming apparatus **100**, a post-processing apparatus **200**, and an image reading apparatus **300**. The post-processing apparatus **200** has a sheet stacking function, a sheet aligning function, and a sheet bundle binding function.

The image forming apparatus **100** is an indirect transfer tandem type image forming device that forms a color image, and functions as an image forming device that forms an image on a sheet P that serves as a medium. The image forming apparatus **100** includes an image forming device **110** in which image forming stations **111** for four colors are disposed, and an optical writing device **113** provided below and adjacent to the image forming device **110**. The image forming apparatus **100** includes a sheet feeding device **120** and a sheet feeding conveyance path **130**. The sheet feeding device **120** is provided below the image forming device **110**. The sheet feeding conveyance path **130** guides the sheet P picked up by the sheet feeding device **120** to convey the sheet P to a secondary transfer device **140** and the fixing device **150**. The image forming apparatus **100** includes a sheet discharge path **160** and duplex conveyance paths **170**. The sheet discharge path **160** guides a sheet P on which an image has been fixed to convey the sheet P to the post-processing apparatus **200**. The duplex conveyance paths **170** reverse (switch back) the sheet P on one side of which an image has been formed and guides the sheet P to the sheet feeding conveyance path **130** to form an image on the other side of the sheet P.

Each of the image forming stations **111** of the image forming device **110** includes a photoconductor drum for each color of Y, M, C, and K, a charger, a developing device, a primary transfer device, a cleaner, a discharger, and the like disposed along the outer circumference of each of the photoconductor drums. The image forming device **110** includes an intermediate transfer belt **112** to which images formed on the photoconductor drums are transferred by the primary transfer device, and the optical writing device **113** that writes an image on each of the photoconductor drums for each color. The optical writing device **113** is disposed below the image forming stations **111**, and the intermediate transfer belt **112** is disposed above the image forming stations **111**. The intermediate transfer belt **112** is rotatably supported by a plurality of support rollers. A support roller **114** as one of the support rollers faces a secondary transfer roller **115** as a secondary transfer device via the intermediate transfer belt **112** in the secondary transfer device **140**, and secondarily transfers the image on the intermediate transfer belt **112** onto the surface of the sheet P. As such an image forming process, a known process other than the above may be adopted.

The sheet feeding device **120** includes a sheet feeding tray **121**, pickup rollers **122**, and sheet feeding conveyance rollers **123**, and feeds the sheet P picked up from the sheet feeding tray **121** upward along the sheet feeding conveyance path **130**. An image is transferred onto the fed sheet P by the secondary transfer device **140** and the sheet P is conveyed to the fixing device **150**. The fixing device **150** includes fixing rollers and pressure rollers and heats and pressurizes the sheet P while the sheet P passes through nips between the fixing rollers and the pressure rollers to fix toner onto the sheet P.

The sheet discharge path **160** and the duplex conveyance paths **170** are provided downstream of the fixing device **150**. A bifurcating claw **161** as a bifurcating member is switched to guide the sheep P to either one of the sheet discharge path **160** and the duplex conveyance paths **170**. Thus, the conveyance path is selected between a case in which the sheet P is conveyed to the post-processing apparatus **200** and a case in which the sheet P is conveyed to the duplex conveyance paths **170**. A pair of bifurcating conveyance rollers **162** is provided immediately upstream of the bifurcating claw **161** in the sheet conveyance direction to apply a conveyance force to the sheet P.

The post-processing apparatus **200** performs predetermined processing (for example, alignment) on the image-formed sheet P conveyed from the image forming apparatus

100, and stacks the image-formed sheet P on an ejection tray 204 located most downstream of the conveyance path. The detail of such processing is described later. In addition, the post-processing apparatus 200 performs a predetermined post-processing (for example, binding) on an end of a sheet bundle Pb formed by performing alignment on the image-formed sheets P conveyed from the image forming apparatus 100, and stacks the sheet bundle Pb on the ejection tray 204 located most downstream of the conveyance path. Note that when the image reading apparatus 300 is provided as illustrated in FIG. 1, the post-processing apparatus 200 is mounted in a space formed in a housing of the image forming apparatus 100 between the image forming apparatus 100 and the image reading apparatus 300, which is originally used as a discharge destination of the sheet P. Such a configuration can achieve both space saving and reduction of an installation area.

A controller 260 disposed in the post-processing apparatus 200 is a substrate including, for example, a central processing unit, a main storage device, an auxiliary storage device, and the like, and is a device that operates each piece of hardware by software processing. The controller 260 inputs detection signals indicating the presence or absence of the sheet P from sensors installed in each conveyance path, performs conveyance control of the sheet P in the post-processing apparatus 200 based on the detection signals, and performs operation control of units described later. Note that the image forming system 1 is controlled by a control unit provided in the image forming apparatus 100 communicating with the controller 260. However, instead of such a configuration, each unit in the post-processing apparatus 200 and each processing unit in the post-processing apparatus 200 may be collectively controlled.

The image reading apparatus 300 optically scans a document set on an exposure glass to read an image on a surface of the document. A known configuration and known functions may be employed as the configuration and functions of the image reading apparatus 300 itself.

The image forming apparatus 100 configured as described above generates image data to be used for writing based on document data read by the image reading apparatus 300 or print data transferred from an external personal computer or the like. Then, the optical writing device 113 performs optical writing on each of the photoconductor drums based on the image data, and the image formed for each color in each of the image forming stations 111 is sequentially transferred to the intermediate transfer belt 112. As a result, a color image in which images of four colors are superimposed is formed on the intermediate transfer belt 112. On the other hand, a sheet P is fed from the sheet feeding tray 121 in accordance with image formation. The sheet P is temporarily stopped at a position of a registration roller pair immediately before the secondary transfer device 140 and conveyed in synchronization with the timing of the leading end of the image on the intermediate transfer belt 112. Then, the sheep P is secondarily transferred by the secondary transfer device 140 and conveyed to the fixing device 150.

The sheet P on which the image has been fixed in the fixing device 150 is conveyed to the sheet discharge path 160 by the switching operation of the bifurcating claw 161 in a case of simplex printing and in a case of duplex printing after both sides of the sheet P have been printed, and is conveyed to the duplex conveyance path 170 in the case of duplex printing. The sheet P conveyed to the duplex conveyance path 170 is inverted and then conveyed again to the secondary transfer device 140, at which an image is formed on the other side of the sheet P, and the sheet P is conveyed to the sheet discharge path 160. The sheet P conveyed to the sheet discharge path 160 is conveyed to the post-processing apparatus 200, subjected to a predetermined processing such as binding by the post-processing apparatus 200, or discharged to the ejection tray 204 without processing.

Outline of Post-Processing Apparatus

FIG. 2 is a schematic top view of the post-processing apparatus 200 according to the present embodiment. FIG. 3 is a schematic side view of the post-processing apparatus 200 according to the present embodiment. FIGS. 2 and 3 each illustrate a basic configuration applied to the embodiments of the present disclosure. The post-processing apparatus 200 includes, viewed from upstream in the conveyance direction of the sheets P, an inlet roller pair 202, a sheet surface detection feeler 211, a rear end reference fence 210, and a sheet discharge roller pair 203, jogger fences 205 and 206, a rear end guide 208, a leading end stopper 207, and the ejection tray 204. The jogger fences 205 and 206 as sheet aligning members align side edges (end portions) of the sheets P in the width direction of the sheet P to form an aligned sheet bundle Pb. The post-processing apparatus 200 includes a stapler 209 that serves as a binding device in addition to the configuration of the post-processing apparatus 200.

The jogger fence 205 on a back side corresponding to a right side in the conveyance direction of the sheet P and the jogger fence 206 on a front side corresponding to a left side in the conveyance direction of the sheet P are supported by a guide shaft 213 and provided to be movable in the axial direction of the guide shaft 213. Each of the jogger fences 205 and 206 includes a sheet rear end receiver 212. The sheet P is conveyed from a +X direction toward a −X direction illustrated in FIG. 2. The leading end stopper 207 as a sheet front end aligning member that aligns the front end of the sheet P is provided downstream in the conveyance direction of the sheet P.

A guide plate that receives the sheet P from the discharge conveyance path of the image forming apparatus 100 is disposed in a sheet receiving space of the post-processing apparatus 200. The inlet roller pair 202 is disposed on an extreme upstream of the guide plate in the conveyance direction of the sheet P. The sheet discharge roller pair 203 having a function of shifting the sheet P to the ejection tray 204 and discharging the sheet P is disposed on an extreme downstream in the conveyance direction of the sheet P.

The inlet roller pair 202 and the sheet discharge roller pair 203 are rotated by an inlet motor to convey the sheet P in the post-processing apparatus 200 along the guide plates.

Each of the jogger fences 205 and 206 includes a stacker that stacks ends of the sheet P in the width direction (Y direction) of the sheet P discharged from the sheet discharge roller pair 203 and an aligning unit that contacts side ends of the sheet P in the width direction of the stacked sheet P to align the sheet P in the width direction, and functions also as a stacker.

The sheet discharge operation of the post-processing apparatus 200 includes three modes such as a shift mode, a straight ejection mode, and a stapling mode. In the shift mode, the sheet P shifts to a different position for each job and is ejected. In the straight ejection mode, the sheet P is ejected as it is. In the stapling mode, a plurality of sheets P is bound as a sheet bundle Pb and the sheet bundle Pb is ejected. The operations in the shift mode and the straight ejection mode are the same as operations of the conventional

technology. Accordingly, the configuration and the operation of each unit in the stapling mode are described below.

The operations in the stapling mode in the post-processing apparatus **200** are described below. The stapling mode is an operation mode in which the stapler **209** binds an end of the sheet bundle Pb. Accordingly, after the alignment is performed in the post-processing apparatus **200**, the binding is performed by the stapler **209**. As will be described later, the alignment is performed by the post-processing apparatus **200** and then the binding is performed by the post-processing apparatus **200** in a series of operations in the stapling mode.

FIG. **4** is a schematic side view of the post-processing apparatus **200** in which the operations in the stapling mode are performed, according to the present embodiment. FIG. **5** is a schematic top view of the post-processing apparatus **200** in which the operations are performed, according to the present embodiment. In the stapling mode, as illustrated in FIGS. **4** and **5**, the ejection tray **204**, the jogger fences **205** and **206**, and the leading end stopper **207** move to sheet receiving positions in the post-processing apparatus **200**. At this time, the ejection tray **204** moves to a position indicated by a dotted line in FIGS. **4** and **5**, that is, a downward position by 30 mm away from bottom surfaces of the jogger fences **205** and **206**. Further, the jogger fences **205** and **206** are moved to the sheet receiving positions, which are positions about 7 mm outside with respect to edges of the sheet P to be discharged. Note that the sheet receiving position of the leading end stopper **207** is preferably set to a position upstream of the conveyance direction of the jogger fences **205** and **206**, which corresponds to the length of the sheet P added by 25 mm from the sheet rear end receiver **212**.

When the movement of the ejection tray **204** is completed, the sheet surface detection feeler **211** is retracted to an upstream side of the rear end reference fence **210** in the conveyance direction. The sheet surface detection feeler **211** comes into contact with the upper surface of an uppermost sheet P placed on the ejection tray **204**, and turns on a sheet surface detection sensor when the position of the upper surface of the uppermost sheet P is smaller than 30 mm from the bottom surfaces of the jogger fences **205** and **206**, and turns the sheet surface detection sensor off when the position of the upper surface of the uppermost sheet P is larger than the 30 mm. The on and off state of the position detection sensor is switched depending on the position of the sheet surface detection feeler **211**. Accordingly, the stacking height of the sheets P is detected.

Further, at the same time when the ejection tray **204**, the jogger fences **205** and **206**, and the leading end stopper **207** move, the stapler **209** is moved to a predetermined binding position by a binding unit movement motor.

After the ejection tray **204**, the jogger fences **205** and **206**, and the leading end stopper **207** are moved to the sheet receiving position and the movement is complete, the sheet P is discharged from the sheet discharge roller pair **203** to the jogger fences **205** and **206**, and the rear end guide **208** waiting at an upper portion of the ejection tray **204** is lowered toward the ejection tray **204** at the timing when the rear end of the sheet P comes out of the sheet discharge roller pair **203**. The above-described operation allows the next sheet P to be discharged without the rear end of the sheet P falling from the sheet discharge roller pair **203** and the occurrence of jamming can be prevented.

After the rear end guide **208** is lowered, as illustrated in FIG. **6**, the leading end stopper **207** moves from the standby position (sheet receiving position) to upstream in the conveyance direction. Then, the leading end stopper **207** moves to an end aligning position indicated by the solid line in FIG. **6** with respect to the sheet P received by the jogger fences **205** and **206**. As a result, the leading end and the rear end of the sheet P in the conveyance direction are sandwiched between the leading end stopper **207** and the sheet rear end receiver **212**. Accordingly, the positions of the leading ends and the rear ends of the sheet P in the conveyance direction are aligned. At the same time when the leading ends and the rear ends of the sheet P in the conveying direction are aligned, the jogger fences **205** and **206** sandwich the sheet P in the width direction, thereby aligning side ends of the sheet P. After the alignment of the sheet P is completed, the jogger fences **205** and **206**, the leading end stopper **207**, and the rear end guide **208** move to the standby position again.

The above alignment operation is repeated from the first sheet P to the last sheet P. When the alignment operation of the last sheet P is completed, the leading end stopper **207** is retracted from between the jogger fences **205** and **206** (sheet receiving position). Then, the jogger fences **205** and **206** move the stapler **209**, which is disposed on a rear side as illustrated in FIG. **7**, to the binding position corresponding to a processing region (processing space) while relatively holding the sandwiching position of the sheet P in the width direction. The above-described movement of the jogger fences **205** and **206** allows the sheet bundle Pb whose side ends are aligned to be moved to the binding position. After the jogger fences **205** and **206** have moved to the binding position, binding is performed by the stapler **209**.

After the completion of the binding by the stapler **209**, the jogger fences **205** and **206** are moved to positions at which the alignment of the sheets P in the width direction has been performed. In addition, the leading end stopper **207** is also moved to the position at which the sheets P are aligned in the conveyance direction. Subsequently, as indicated by solid lines in FIG. **8**, after the jogger fences **205** and **206** and the leading end stopper **207** have been moved, the jogger fences **205** and **206** are moved outward so as to be separated from each other. This movement causes the sheet bundle Pb to fall onto the ejection tray **204** positioned below the jogger fences **205** and **206**. After the sheet bundle Pb falls onto the ejection tray **204**, the jogger fences **205** and **206** and the leading end stopper **207** move to the sheet receiving position to receive the sheet P conveyed next.

After the sheet P is dropped from the jogger fences **205** and **206**, the sheet surface detection feeler **211** returns from the retracted position to detect the height of the sheet bundle Pb stacked on the ejection tray **204**. In accordance with the detection result, the ejection tray **204** is lowered to a position corresponding to the thickness of the stacked sheet bundle Pb. The lowering operation of the ejection tray **204** allows the distance from the bottom surfaces of the jogger fences **205** and **206** to the uppermost sheet P on the ejection tray **204** to be kept constant. Thus, a large number of sheets P can be stacked. Note that when all print jobs are completed, the ejection tray **204** is lowered to the lowermost position (initial position).

Basic Configuration of Stapler **209**

FIG. **9** illustrates a basic configuration of the stapler **209** according to the present embodiment. The stapler **209** includes a clincher **291** and a driver **292**. The space or in which the clincher **291** operates to press staples N protruding from the driver **292** corresponds to the processing region in which binding is performed. After the side ends of the sheet bundle Pb are moved and has entered the processing

region as the binding position by the jogger fences **205** and **206**, the driver **292** causes the staples N to protrude and penetrate an end of the sheet bundle Pb. Subsequently, the clincher **291** presses and bends the ends (leading ends) of the staples N that have penetrated the sheet bundle Pb. The binding of the sheet bundle Pb is executed as described above. The operation of the clincher **291** that moves up and down so as to bend and fix the staples N on the sheet bundle Pb and the operation of the driver **292** that causes the staples N to protrude and penetrate the sheet bundle Pb are performed by a stapler driving source controlled by the controller **260**.

First Embodiment

FIGS. **10**A, **10**B, and **10**C are diagrams each illustrating the stapler **209** according to a first embodiment of the present disclosure. FIG. **10**A illustrates the stapler **209** in a state in which the sheet bundle Pb has moved (entered) into the processing region, and illustrates a pre-execution stage of binding process. FIG. **10**B illustrates the stapler **209** in a stage in which binding is performed on the sheet bundle Pb in the processing region. FIG. **10**C illustrates the stapler **209** in an avoidance stage that occurs when the binding is executed in a state in which the sheet bundle Pb is present in the processing region and a foreign object F (for example, a part of the user's finger) has entered the processing region.

As illustrated in FIGS. **10**A, **10**B, and **10**C, the stapler **209** includes the clincher **291**, the driver **292**, a shutter **293** as a closing member, a shutter driver **296** as a driver, and a changeover switch **297** as a changeover switch. Since the clincher **291** and the driver **292** have already been described, the details thereof is omitted.

The shutter **293** includes an avoidance operation portion **294** and a drive coupler **295**. The avoidance operation portion **294** closes an opening serving as an entrance through which the sheet bundle Pb is moved to a space (binding position) in which the clincher **291** presses the staples to perform binding, and avoids a closing operation of the opening when the movement of the sheet bundle Pb is prevented when the sheet bundle Pb moves to a closing position. The drive coupler **295** transmits drive force to move the avoidance operation portion **294** to the closing position. The closing position is a position at which the avoidance operation portion **294** blocks the space including the binding position from outside to prevent an object (foreign object) other than the sheet bundle Pb from entering through the opening.

The avoidance operation portion **294** includes a coupling hole **2941** as a coupler for coupling with the drive coupler **295**. The drive coupler **295** includes a protrusion **2951** as a coupling portion to be fitted into the coupling hole **2941**. The avoidance operation portion **294** moves to the closing position in conjunction with the movement of the drive coupler **295** when the drive coupler **295** is moved by the driving force caused by the shutter driver **296** in a state in which the protrusion **2951** as the coupler and the coupling hole **2941** remain in the fitted state (coupling state).

The drive coupler **295** includes a rack gear **2952** as a driving force receiver for receiving the driving force caused by the shutter driver **296**, in addition to the protrusion **2951** for transmitting the driving force to the avoidance operation portion **294**. The protrusion **2951** has a hemispherical shape and is formed so as to be fitted into the coupling hole **2941** of the avoidance operation portion **294** with a fitting degree such that the fitted state (coupling state) is released when the drive coupler **295** continues to move in a state in which the movement of the avoidance operation portion **294** is prevented.

The shutter driver **296** includes a closing drive motor **2961** as a drive source and a pinion gear **2962** as a closing drive gear fixed to a drive shaft of the closing drive motor **2961**. The pinion gear **2962** meshes with the rack gear **2952** and transmits a driving force to move the drive coupler **295** in a vertical direction when the closing drive motor **2961** is driven.

The changeover switch **297** as a changeover device is disposed at a position at which an operation of turning on the changeover switch **297** is performed when the avoidance operation portion **294** is moved to the closing position. The changeover switch **297** opens and closes a power supply circuit that supplies operating power to the stapler **209**. When the changeover switch **297** is turned on, the "executable state" in which the binding operation by the stapler **209** is executed is set.

Operation of Shutter **293** (Including Avoidance Operation)

Next, the operation of the stapler **209** including the shutter **293** is described. When the sheet bundle Pb is moved to the binding position, the controller **260** first drives the closing drive motor **2961** to rotate the pinion gear **2962**. Thus, the drive coupler **295** is moved toward the changeover switch **297**. The avoidance operation portion **294** moves toward the closing position (FIG. **10**A) in conjunction with the movement of the drive coupler **295**.

When the avoidance operation portion **294** moves to the closing position, the changeover switch **297** installed in the movement direction is operated (pressed) by the avoidance operation portion **294**. When the changeover switch **297** is pressed, the power supply circuit to the driver **292** of the stapler **209** is closed, and the driver **292** and the clincher **291** that serves as a binding device are switched to an executable state in which the binding operation can be executed. Thus, the staples N are protruded and the pressing operation of the staples N by the clincher **291** is performed. That is, operating the changeover switch **297** allows the drive source included in the driver **292** to be operable and the clincher **291** also to be operable.

At this time, the opening is closed by the avoidance operation portion **294** and only the sheet bundle Pb is present at the binding position. That is, when the stapler **209** is in a state in which the binding operation can be performed by the movement of the avoidance operation portion **294**, the opening is blocked from the outside by the avoidance operation portion **294** and the entry of a foreign object F is prevented. Thus, the foreign object F being caught in the avoidance operation portion **294** and the foreign object F entering the binding position when the binding operation is executable can be prevented.

On the other hand, when the closing drive motor **2961** is driven by the controller **260** to start the movement of the drive coupler **295**, and the movement of the avoidance operation portion **294** is prevented in the middle of the movement of the avoidance operation portion **294** toward the closing position in conjunction with the movement, the coupling state between drive coupler **295** and the avoidance operation portion **294** is released. For example, when there is the foreign object F at the entrance or when the foreign object F has entered the binding position, the foreign object F is caught between the avoidance operation portion **294** and the driver **292**. In such a state, the avoidance operation

portion **294** cannot move to the closing position, and the movement of the avoidance operation portion **294** is prevented.

Even if the movement of the avoidance operation portion **294** is blocked by the foreign object F, the drive coupler **295** continues to move by the driving force of the closing drive motor **2961**. Thus, the protrusion **2951** is disengaged from the coupling hole **2941** and the fitted state (coupling state) is released. When the coupling state of the avoidance operation portion **294** with the drive coupler **295** is released, the avoidance operation portion **294** loses the driving force and stops. In this case, the avoidance operation portion **294** stops without reaching the closing position.

When the avoidance operation portion **294** stops without moving to the closing position, as described above, the changeover switch **297** is not operated and the binding process is disabled. That is, the binding process is avoided by the avoidance operation portion **294**.

The stapler **209** according to the present embodiment can detect the difference between the thickness of the sheet bundle Pb having the predetermined number of sheets to be bound and the thickness of the foreign object F. Accordingly, when the gap between the shutter **293** and the driver **292** is smaller than the thickness of the sheet bundle Pb having the predetermined number of sheets to be bound, the changeover switch **297** is operated to set the binding process in the executable state.

In the present embodiment, the predetermined number of sheets to be bound is, for example, the maximum number of sheets of plain paper to be bound, and the maximum number of sheets to be bound may be increased or decreased depending on the thickness of the paper to be used. When the gap is larger than the thickness of the predetermined number of sheets to be bound, power is not supplied to the driver **292** of the stapler **209**. Therefore, even if the sheet bundle Pb is removed when the sheet bundle Pb is bound and the foreign object F enters the empty space, the power supply to the driver **292** can be kept cut off.

As illustrated in FIG. **10**A, when the side ends of the sheets P constituting the sheet bundle Pb are largely bent, preferably, the shutter **293** stands by in a gap smaller than the gap of the opening when the sheet bundle Pb is made to enter from the opening and is moved to the binding position. This is to prevent the sheets P from being caught by a step between the shutter **293** and the driver **292**.

When the sheet bundle Pb is bound, the shutter **293** is in a closed state in which the opening is closed. In this closed state, the shutter **293** closes the entrance until the thickness of a predetermined number of sheets to be bound is reached. However, the stapler **209** also performs the binding operation on the sheet bundle Pb of which the number of sheets is equal to or less than the predetermined number of sheets to be bound. Accordingly, the binding operation by the driver **292** and the clincher **291** can be performed even when the gap formed at the entrance closed by the shutter **293** is smaller than the thickness of the predetermined number of sheets to be bound.

Note that the drive coupler **295** only needs to vary the gap (opening amount of the opening) of the shutter **293** and the driver configuration to move the shutter **293** is not limited to the combination of the closing drive motor **2961** and the rack and pinion gear mechanism. For example, belt transmission or an electromagnetic solenoid may be used for the driver configuration.

The stapler **209** according to the present embodiment can switch the position of the shutter **293** between the position in which the opening for allowing the sheet bundle Pb to enter and exit the binding position is widely opened and the position in which the opening is closed to prevent the foreign object F from entering (closing position). Setting the shutter **293** to the widely opened position by the above-described position switching operation allows to reduce the conveyance resistance when the sheet bundle Pb whose side ends are largely bent enters the opening.

The fitting force between the protrusion **2951** and the coupling hole **2941** is set to be stronger than the force with which the avoidance operation portion **294** presses the changeover switch **297**. In addition, the fitting force between the protrusion **2951** and the coupling hole **2941** is set to be weaker than the force for moving the drive coupler **295** by the shutter driver **296** when the movement of the avoidance operation portion **294** is blocked and stopped. Therefore, when the movement of the avoidance operation portion **294** to the closing position is blocked and stopped, the transmission of the driving force to the avoidance operation portion **294** is blocked and the avoidance operation portion **294** stops in a state in which the foreign object F is sandwiched by its own weight. At this time, the force applied to the foreign object F is small. Accordingly, the foreign object F can be easily pulled out and removed.

Return Operation

Next, as illustrated in FIG. **10**C, when the coupling state between the avoidance operation portion **294** and the drive coupler **295** is released, that is, when the fitting between the coupling hole **2941** and the protrusion **2951** is released, an operation to return the state to the fitted state is described with reference to FIGS. **11**A and **11**B.

As illustrated in FIG. **11**A, when the state in which the coupling state between the avoidance operation portion **294** and the drive coupler **295** is released is returned to the state illustrated in FIG. **10**A, the user may manually return the protrusion **2951** which is detached from the coupling hole **2941**.

Alternatively, the shutter driver **296** may be driven to move the shutter **293** so as to open the opening, thereby fitting the protrusion **2951** into the coupling hole **2941**. In such a case, as illustrated in FIG. **11**, a wall **298** disposed above the stapler **209** is used. When the controller **260** operates the shutter driver **296** to move the drive coupler **295** upward from the state of FIG. **11**A, the avoidance operation portion **294** also moves upward due to friction between the protrusion **2951** and the avoidance operation portion **294**. At this time, as illustrated in FIG. **11**B, the avoidance operation portion **294** located above the drive coupler **295** first comes into contact with the wall **298**. After that, when the shutter driver **296** is driven, the drive coupler **295** moves upward while the avoidance operation portion **294** remains in contact with the wall **298** and stopped. As a result, as illustrated in FIG. **11**C, the protrusion **2951** is fitted into the coupling hole **2941** and can be returned to the original state.

Note that the method of coupling the avoidance operation portion **294** and the drive coupler **295** is not limited to the method of fitting the coupling hole **2941** and the protrusion **2951** as described above. For example, power may be transmitted using frictional power transmission. In this case, the friction is set to be larger than the force for pressing down the changeover switch **297**, and the driving force for pressing down the avoidance operation portion **294** is set to be larger than the force for sliding the avoidance operation portion **294** with respect to the drive coupler **295**.

Further, the movement of the drive coupler **295** that moves in a predetermined direction by the driving force

caused by the shutter driver **296** is not limited to linear movement and may be rotational movement. Similarly, the movement of the avoidance operation portion **294** is not limited to the linear movement, and may be a rotational movement as long as the avoidance operation portion **294** moves to the closing position to bring the entrance into the closing position.

Operation Procedure in Stapling Mode

FIG. **12** including FIGS. **12***a* and **12**B is a flowchart of a series of operation performed at the stapler **209** described above in a stapling mode, according to the present embodiment. The operations in this flowchart are performed based on instructions or control signals sent from the controller **260**. Note that details of the operation have been described as above, a brief description is given below.

When the operation in the stapling mode is started, the ejection tray **204** and the jogger fences **205** and **206** are moved from the home position to the sheet receiving position, and the stapler **209** is moved from the home position to the predetermined stapling position (S**1201**). Then, the leading end stopper **207** is moved from the home position to the sheet receiving position, and the sheet surface detection feeler **211** is retracted from the detection position (S**1202**).

When the sheet P is discharged from the sheet discharge roller pair **203** (S**1203**), the rear end guide **208** descends to press the sheet P from above (S**1204**), and the jogger fences **205** and **206** and the leading end stopper **207** align the sheets P (S**1205**). After the sheets P are aligned, the jogger fences **205** and **206** and the leading end stopper **207** are moved to the sheet receiving position, and the rear end guide **208** is lifted (S**1206**).

The controller **260** determines whether the sheet P is the last sheet (S**1207**) and if the sheet P is not the last sheet (NO in S**1207**), the process returns to S**1203**, and steps from S**1203** to S**1207** are repeated until the sheet P is the last sheet. If the sheet P is the last sheet (YES in S**1207**), the leading end stopper **207** moves to the retreat position (S**1208**). Thereafter, the jogger fences **205** and **206** are moved to the stapling position while holding the sheet bundle Pb (S**1209**).

After the jogger fences **205** and **206** are moved to the stapling position, the controller **260** drives the shutter driver **296** to move the shutter **293** to the closing position (S**1210**). When the shutter **293** moves to the closing position, the power supply circuit to the driver **292** is closed. Thus, the binding process by the stapler **209** is executed (S**1211**). When the binding process ends, the shutter driver **296** is operated to return the shutter **293** from the closing position to the initial position (S**1212**).

After the shutter **293** returns to the initial position and the opening is opened, the jogger fences **205** and **206** are moved to the sheet discharge position (S**1213**). After the jogger fences **205** and **206** are moved, the leading end stopper **207** is also returned to the initial position (S**1214**). Then, the jogger fences **205** and **206** are moved away from each other to drop the sheet bundle Pb (S**1215**).

After the sheet bundle Pb falls onto the ejection tray **204**, the sheet surface detection feeler **211** is returned (moved) to the detection position, and the jogger fences **205** and **206** are moved to the sheet receiving position (S**1216**), and the ejection tray **204** is lowered (S**1217**). This lowering of the ejection tray **204** is performed until the sheet surface detection sensor is turned off (loop of NO in S**1218**). When the sheet surface detection sensor is turned off (YES in S**1218**), the lowering of the ejection tray **204** is stopped (S**1219**).

Thereafter, the controller **260** determines whether the job is completed (S**1220**). When the job is not completed (NO in S**1220**), the process returns to S**1202**. When the job is completed (YES in S**1220**), the ejection tray **204**, the jogger fences **205** and **206**, the leading end stopper **207**, and the stapler **209** are moved to the home position (S**1221**), and the process described in the flowchart of FIG. **12** ends. Note that the jogger fences **205** and **206** may be moved to the sheet receiving position immediately before S**1216**, instead of S**1220**.

As described above, performing the binding after the shutter **293** closes the opening (S**1211**) allows to supply power to the driver **292** of the stapler **209** by the changeover switch **297** and to perform the binding process when the gap of the shutter **293** is equal to or less than the thickness of the predetermined number of sheets to be bound. When the gap of the shutter **293** is larger than the thickness of the predetermined number of sheets to be bound, the changeover switch **297** does not operate and power is not supplied to the driver **292** of the stapler **209**. Accordingly, the binding process is not executed. At this time, when the signal of the changeover switch **297** is used as a trigger to transmit the signal of the binding process, the control signal for performing the binding process may not be transmitted.

Second Embodiment

FIGS. **13**A, **13**B, and **13**C are diagrams each illustrating a stapler **209** according to a further alternative embodiment of the present disclosure. As illustrated in FIGS. **13**A, **13**B, and **13**C, a stapler **209***a* according to the second embodiment has a similar configuration to that of the first embodiment in regard to the clincher **291**, the driver **292**, the shutter driver **296**, and the changeover switch **297** described above. However, the stapler **209***a* according to the second embodiment includes a shutter **293***a* that is different from the shutter **293** according to the first embodiment. Hereinafter, the differences in configuration between the shutter **293***a* according to the second embodiment and the shutter **293** according to the first embodiment are mainly described.

The shutter **293***a* according to the present embodiment includes an avoidance operation portion **294***a*, and a drive coupler **295***a*. The avoidance operation portion **294***a* avoids the closing operation when the movement of the shutter **293***a* is prevented when the shutter **293***a* moves to the closing position. The drive coupler **295***a* transfers a driving force to move the avoidance operation portion **294***a* to the closing position.

The avoidance operation portion **294***a* includes a fitted protrusion **2942** as a coupler to be interlocked with the drive coupler **295***a*. The drive coupler **295***a* includes a torsion spring **2956** as a coupling elastic member and a coupling protrusion **2953**. One end of the torsion spring **2956** is fixed to the fitted protrusion **2942**, and the other end of the torsion spring **2956** is fixed to the coupling protrusion **2953**. The torsion spring **2956** is biased in a rewinding direction, and the avoidance operation portion **294***a* is biased downward.

The biasing force of the torsion spring **2956** may be set to be larger than the force for operating or pressing the changeover switch **297**. When the shutter driver **296** is operated to move the drive coupler **295***a* downward, the torsion spring **2956** is also moved together with the drive coupler **295***a*. At this time, the other end of the torsion spring **2956** is fixed to the coupling protrusion **2953**. Accordingly, force is applied to the fitted protrusion **2942** on another end of the torsion spring **2956** in a push-down direction. Therefore, in conjunction with the downward movement of the drive coupler

295*a*, the avoidance operation portion **294***a* also moves downward, that is, toward the changeover switch **297**.

When the avoidance operation portion **294***a* moves to the closing position, the changeover switch **297** is pressed, and the clincher **291** and the driver **292** are in a state in which the binding operation can be executed.

Note that as the connecting elastic member, an elastic member such as a tension spring, a compression spring, or rubber may be used. Any elastic member may be used as long as the elastic member can exert the biasing force larger than the pressing force for the changeover switch **297**.

As in the stapler **209***a*, using an elastic member as the coupling elastic member to engage with the avoidance operation portion **294***a* allows to return to the coupling state between the drive coupler **295***a* and the avoidance operation portion **294***a*, if the foreign object F is pulled out when the foreign object F is caught in the entrance (see FIG. **13**C). Thus, returning to the avoidance operation can be facilitated. In addition, when the foreign object F is pulled out from the state in which the foreign object F is sandwiched, the shutter **293** returns to the initial position to press the changeover switch **297**. Thus, there is a possibility that the state shifts to a state in which the binding process can be executed. However, in the case of the stapler **209***a*, the binding process is not executable unless the foreign object F is pulled out. Thus, the foreign object F is prevented from being sandwiched by the clincher **291** or the like.

Third Embodiment

FIGS. **14**A, **14**B, and **14**C are diagrams each illustrating a stapler **209***b* according to a further alternative embodiment of the present disclosure. As illustrated in FIGS. **14**A, **14**B, and **14**C, a stapler **209***b* according to the third embodiment has a similar configuration as the first and second embodiments of the present disclosure and includes the clincher **291**, the driver **292**, a shutter **293***b*, the shutter driver **296**, and the changeover switch **297** described above. However, the detailed configuration of the shutter **293** and the shutter driver **296** are different. Hereinafter, the differences in configuration between the shutter **293***a* according to the second embodiment and the shutter **293** according to the first embodiment are mainly described.

The avoidance operation portion **294***b* constituting the shutter **293***b* includes a closing portion and a switch operation portion. The closing portion functions to close the entrance. The switch operation portion functions to operate the changeover switch **297***b* and is rotated by a driving force of the drive coupler **295***b*.

The drive coupler **295***b* includes a fan-shaped gear **2954** that rotates by driving of the shutter driver **296***b*, and a torsion spring **2956***b* attached to a rotation shaft of the fan-shaped gear **2954**. One end of the torsion spring **2956***b* is fixed to the coupling protrusion **2953***b*, and the other end of the torsion spring **2956***b* is fixed to the fitted protrusion **2942***b* formed in the avoidance operation portion **294***b*. The torsion spring **2956***b* is a connecting elastic member having a biasing force in a winding direction, and biases the avoidance operation portion **294***b* in a direction in which the entrance is closed.

The shutter driver **296***b* is a motor in which a gear is fixed to a rotation shaft of the motor and is engaged with the fan-shaped gear **2954**. The fan-shaped gear **2954** rotates clockwise (CW) by the rotation of the shutter driver **296***b*. The coupling protrusion **2953***b* formed on the fan-shaped gear **2954** pushes one end of the torsion spring **2956***b* clockwise. The torsion spring **2956***b* is biased in the winding direction. Thus, the fitted protrusion **2942***b* fixed to the other end of the torsion spring **2956***b* is biased clockwise.

When the controller **260** rotates the shutter driver **296***b* in a series of controls to execute the binding process, the fan-shaped gear **2954** rotates clockwise and biases the fitted protrusion **2942***b* clockwise. Accordingly, the avoidance operation portion **294***b* closes the entrance (FIG. **14**B). At this time, the switch operation portion of the avoidance operation portion **294***b* also rotates clockwise. As a result, the changeover switch **297***b* is pressed. The changeover switch **297***b* opens and closes the power supply circuit to the drivers of the driver **292** and the clincher **291**. Thus, the power supply circuit is closed when the changeover switch **297***b* is pressed and the driver **292** and the clincher **291** are in a state in which the binding can be executed.

Note that also in the coupling elastic member according to the present embodiment, an elastic member such as a tension spring, a compression spring, or rubber may be used. Any elastic member may be used as long as the elastic member can exert the biasing force larger than the pressing force for the changeover switch **297**.

Fourth Embodiment

FIGS. **14**A, **14**B, and **14**C are diagrams each illustrating a stapler **209***c* according to a further alternative embodiment of the present disclosure. As illustrated in FIGS. **15**A, **15**B, and **15**C, a stapler **209***c* according to the present embodiment includes a shutter driver **296***c* disposed on a side face of the stapler **209***c* and a changeover switch **297***c* disposed on an opposite side face of the stapler **209***c*. A first shutter portion **2931** and a second shutter portion **2932** constituting a shutter **293***c* are integrally formed. A portion of the shutter **293***c* close to the drive coupler **295***c* is the first shutter portion **2931** and a portion of the shutter **293***c* close to the avoidance operation portion **294***c* is the second shutter portion **2932**.

The shutter **293***c* includes a closing part that functions to close the entrance by transmitting driving force caused by the shutter driver **296***c* on the side close to the drive coupler **295***c*, and a switch operation portion that functions to operate the changeover switch **297***c*.

As illustrated in FIG. **15**C, a tension coil spring **2933** as an elastic member is provided on the second shutter portion **2932** which is a part of the shutter **293***c*. The tension coil spring **2933** is an elastic member that biases the second shutter portion **2932** in a direction opposite to the operation direction of the changeover switch **297***c* with respect to the second shutter portion **2932**.

As illustrated in FIG. **15**A, the shutter **293***c* is integrally operated by the shutter driver **296***c*. However, in a state in which the shutter **293***c* is broken as illustrated in FIG. **15**B, the first shutter portion **2931** and the second shutter portion **2932** are separated from each other, and the driving force caused by the drive coupler **295***c* is not transmitted to the avoidance operation portion **294***c*. At this time, the avoidance operation portion **294***c* is operable without being interlocked with the operation of the drive coupler **295***c*.

In this case, as illustrated in FIG. **15**B, the avoidance operation portion **294***c* may move downward due to its own weight and press the changeover switch **297***c*. Then, even if the foreign object F is caught on a side close to the drive coupler **295***c*, the binding operation is executable.

Therefore, as illustrated in FIG. **15**C, the second shutter portion **2932** is biased by the tension coil spring **2933** so as not to move downward even when the second shutter portion **2932** is separated from the drive coupler **295***c*. Thus, the

stapler **209***c* is not able to execute the binding operation in a state in which the shutter **293***c* sandwiches the foreign object F. That is, according to the present embodiment, even if the shutter **293***c* is broken and the avoidance operation portion **294***c* and the drive coupler **295***c* are separated from each other, control can be performed such that the binding operation is not executable when the foreign object F is interposed. Note that the biasing force of the tension coil spring **2933** may be small enough to prevent the separated shutter **293***c* from hanging down by its own weight.

Fifth Embodiment

FIGS. **16**A, **16**B, and **16**C are diagrams each illustrating a stapler **209***d* according to a third further alternative embodiment of the present disclosure. The stapler **209***d* illustrated in FIGS. **16**A, **16**B, and **16**C includes a shutter **293***d* having a different configuration from the configuration described above. Hereinafter, the shutter **293***d* is mainly described.

An avoidance operation portion **294***d* includes a fitted protrusion **2942** as a coupling portion that is interlocked with the drive coupler **295***d*, and an avoidance detection protrusion **2934**. The drive coupler **295***a* includes a torsion spring **2956** as a coupling elastic member, a coupling protrusion **2953**, and a detection rod **2955**. The detection rod **2955** is rotatably fixed to a pin provided in the drive coupler **295***a*, and moves such that a free end of the detection rod **2955** draws an arc around the pin as the rotation center.

In the stapler **209***d*, the shutter driver **296**, which is a driving source for operating the shutter **293***d*, also serves as a driving source for the driver **292** and the clincher **291** to perform the binding operation. Therefore, the controller **260** controls the driver **292** to operate after the shutter **293** operates to close the entrance to prevent the foreign object F from entering.

In this case, the same driving source is used. Thus, a current flows through the power supply circuit to the driver **292** and the like. For this reason, when the foreign object F thicker than the sheet bundle Pb is sandwiched after the shutter **293***d* is operated, it is necessary to stop the power supply to the driver **292** and the like.

Therefore, when the foreign object F is caught, that is, when the movement of the avoidance operation portion **294***d* to the closing position in conjunction with the drive coupler **295** is prevented, the detection rod **2955** is pushed up by the avoidance detection protrusion **2934**. The changeover switch **297***d* is disposed at a position at which the changeover switch **297***d* can be operated by the pushed-up detection rod **2955**. When the changeover switch **297***d* is operated, power supply to the driver **292** or the like is interrupted.

As described above, in the stapler **209***d* according to the present embodiment, the changeover switch **297***d* detects the position at which the shutter **293***d* sandwiches the foreign object F thicker than the sheet bundle Pb. In addition, the changeover switch **297***d* is not detected at a position at which the sheet bundle Pb is sandwiched. Thus, safety can be secured.

Sixth Embodiment

FIGS. **17**A and **17**B are diagram each illustrating a stapler **209***e* according to a sixth further alternative embodiment of the present disclosure. As illustrated in FIGS. **17**A and **17**B, a stapler **209***e* according to the present embodiment is configured such that the shutter **293***e* covers the entire circumference of the binding position (the space in which the binding process is executed by the clincher **291** and the driver **292**).

For example, in the shutter **293** of the stapler **209**, it is necessary to reduce the conveyance resistance of the sheet P to receive the sheet bundle Pb whose end is largely bent at the binding position. Therefore, it is necessary to provide a large opening area for the entrance to the stapler **209**. When the opening area is large, sound generated when the binding operation is performed is radially spread.

Therefore, in the stapler **209***e*, the shutter **293***e* covers the opening at the binding position up to the thickness of the sheet bundle Pb, such that noise generated during the binding operation can be insulated (see FIG. **17**B).

Seventh Embodiment

FIGS. **18**A and **18**B are diagrams each illustrating a stapler **209***f* according to a further alternative embodiment of the present disclosure. The stapler **209** described above executes the binding on the ends of the sheet bundle Pb. The stapler **209***f* according to the present embodiment is an example of a saddle stitching device that performs a stitching processing on the sheet bundle Pb at middle portions in the conveyance direction.

As illustrated in FIGS. **18**A and **18**B, the stapler **209***f* according to the present embodiment has a basic configuration similar to the configuration of the stapler **209** described above. However, there are differences in the details of the configuration. The differences in configuration between the stapler **209***f* and the stapler **209** are mainly described below.

As illustrated in FIG. **18**A, a driver **292***f* that pushes out the staples N and a clincher **291***f* that bends the staples N are separately disposed in two spaces in the stapler **209***f* and the binding position is set at a position at which the sheet bundle Pb is sandwiched near the center in the longitudinal direction of the sheet bundle Pb. In the stapler **209***f* according the seventh embodiment of the present disclosure, the position of the clincher **291***f* is fixed and does not move when the driver **292***f* operates.

Therefore, the shutter **293***f* (the avoidance operation portion **294***f* and the drive coupler **295***f*) is disposed on a side on which the driver **292***f* is disposed, and the shutter **293***f* is interlocked with the movement direction of the driver **292***f*. In addition, a changeover switch **297***f* is disposed on the side of the avoidance operation portion **294***f*. The changeover switch **297***f* is not pressed when the changeover switch **297***f* cannot interlock with the drive coupler **295***f*.

When the changeover switch **297***f* is not pressed, the driver **292***f* is not operated, and when the foreign object F enters a binding position which is a clearance between the driver **292***f* and the clincher **291***f*, the operation of the driver **292***f* is disabled.

In the case of saddle stitching, since the binding position is near the center of the sheet bundle Pb, the shutter **293***f* of the stapler **209***f* must cover the entire periphery of the unit so that the foreign object F does not enter the binding position.

Eighth Embodiment

FIG. **19** is a diagram illustrating a stapler **209***g* according to a further alternative embodiment of the present disclosure. The stapler **209***g* illustrated in FIG. **19** is another example of

the saddle stitching unit that performs the stitching process on the sheet bundle Pb at the intermediate portion in the conveyance direction.

The stapler **209***g* according to the present embodiment is a device capable of executing the saddle stitching processing on the sheet bundle Pb at a plurality of different positions. In the case of a device that is divided into a plurality of pieces, such as the stapler **209***g*, the binding operation is simultaneously executed at a plurality of binding positions. Therefore, preferably, a shutter **293***g* as the closing member is integrated so as to cover the entire binding positions.

Ninth Embodiment

FIG. **20** is a diagram illustrating a stapler unit **209***h* according to a ninth further alternative embodiment of the present disclosure. As illustrated in FIG. **20**, a stapler **209***h* according to the present embodiment includes, in addition to the configuration of the stapler **209** and the like described above, a protective cover **2981** as a cover constituting a part of a housing of the post-processing apparatus **200**, and a protective switch **2982** as a cover detector operated by the protective cover **2981**. The protective cover **2981** is a cover that opens and closes an opening serving as an entry path from the outside of the apparatus to the inside of the post-processing apparatus **200**.

The stapler **209** and the like described above function when the thickness of the foreign object F is larger than the thickness of the sheet bundle Pb. However, the sheet bundle Pb may be thicker than the foreign object F (for example, the user's finger). In this case, the binding operation cannot be executed only by the shutter **293** and the like according to the embodiments other than the present embodiment described above. That is, an additional control unit is required to make the binding operation executable on the sheet bundle Pb thicker than the assumed thickness of the foreign object F.

Therefore, in the stapler **209***h* according to the present embodiment, whether the binding operation can be performed is controlled in cooperation with the open and close state of the protective cover **2981** which prevents the foreign object F from entering the inside of the apparatus which is the installation space of the stapler **209***h*.

When the protection cover **2981** is at the open position (indicated by a dotted line in FIG. **20**), the protection switch **2982** is not pressed. When the protection cover **2981** is at the closing position (indicated by a solid line in FIG. **20**), the protection switch **2982** is pressed. Closing the power supply circuit to the driver **292** and the like only when the protection switch **2982** is pressed and the changeover switch **297** is also pressed allows to perform control so as not to execute the binding operation when there is a possibility that the foreign object F is caught at the binding position of the stapler **209***h*.

For example, FIG. **21** describes a combination of the state of the changeover switch **297** and the state of the protection switch **2982**, and a state of power supply to the stapler **209***h*. The state of the changeover switch **297** and the protection switch **2982** is represented by "1" for "ON" and "0" for "OFF". The state of the power supply to the stapler **209***h* is represented by "1" and "0". "1" represents the state in which stapler **209***h* is in the power supply state and "0" represents the state in which stapler **209***h* is not in the power supply state.

As described in FIG. **21**, when one of the changeover switch **297** and the protection switch **2982** is ON, power is supplied to the power supply circuit of the stapler **209***h*. In other words, the power supply circuit of the stapler **209***h* may have a circuit configuration in which an OR circuit is formed by the changeover switch **297** and the protection switch **2982**.

The stapler **209***h* can execute the binding operation for the sheet bundle Pb thicker than the predetermined number of sheets to be bound. Further, the difference in thickness between the foreign object F and the sheet bundle Pb can be detected. Thus, when the gap between the shutter **293** and the driver **292** is narrower than the thickness of the predetermined number of sheets to be bound, the binding process is executed by the operation of the changeover switch **297**.

When the gap between the shutter **293** and the driver **292** is wider than the predetermined number of sheets to be bound, the power supply to the driver **292** is stopped. Therefore, even when the sheet bundle Pb is removed from the binding position and the foreign object F enters the binding position during the binding operation on the sheet bundle Pb, the binding operation can be controlled so as to be unfeasible.

FIG. **22** including FIGS. **22**A, **22**B, and **22**C is a flowchart of a series of operations process of performed at the stapler **209***h* in a stapling mode, according to the ninth embodiment of the present disclosure. The operations in this flowchart are performed based on instructions or control signals sent from the controller **260** and some of these operations are in common with the operations performed by the stapler **209** already described with reference to FIG. **12**. Hereinafter, the differences in configuration between the shutter **293***a* according to the second embodiment and the shutter **293** according to the first embodiment are mainly described.

After the operation in the stapling mode is started, the controller **260** determines if the sheet P is final (YES in S**2207**). Thereafter, the controller **260** determines whether the number of sheets of the sheet bundle Pb is larger than a predetermined number of sheets to be bound (S**2208**). When the number of sheets of the sheet bundle Pb is larger than the predetermined number of sheets to be bound (YES in S**2208**), the protection cover **2981** is closed (S**2209**). Then, the leading end stopper **207** is moved to the retreat position (S**2210**). When the predetermined number of sheets is smaller than the predetermined number of sheets to be bound (NO in S**2208**), the protection cover **2981** is not closed and the leading end stopper **207** is moved to the retracted position (S**2210**).

Thereafter, the jogger fences **205** and **206** are moved to the stapling positions while holding the sheet bundle Pb (S**2211**), the shutter **293** is moved to the closing position (S**2212**), and the binding process is executed according to the table illustrated in FIG. **21** (S**2213**).

After the binding process is completed, whether the number of sheets of the sheet bundle Pb is larger than the predetermined number of sheets to be bound is determined again (S**2214**). When the number of sheets of the sheet bundle Pb is larger than the predetermined number of sheets to be bound (YES in S**2214**), the protection cover **2981** is opened (S**2215**). Then, the shutter **293** is returned to the initial position (S**2216**). When the predetermined number of sheets of the sheet bundle Pb is smaller than the predetermined number of sheets to be bound (NO in S**2214**), the shutter **293** is returned to the initial position while the protective cover **2981** remains open (S**2216**).

The procedure after S**2217** and thereafter are the same as S**1213** and thereafter. Therefore, description thereof is omitted.

As described above, in the stapler **209***h*, while the protection cover **2981** is closed, the sheets P and the sheet

bundle Pb inside the post-processing apparatus **200** cannot be taken out, which is inconvenient. Therefore, when the shutter **293** of the stapler **209***h* is closed, it is not necessary to close the protection cover **2981**. Thus, when a small number of sheets are to be bound, the safety can be secured based on the operation of the changeover switch **297** by the shutter **293**. Thus, the safety is not impaired even if the protection cover **2981** is not closed. That is, the convenience of taking out the sheets P and the sheet bundle Pb inside the post-processing apparatus **200** during the operation of the post-processing apparatus **200** can be ensured.

Further, for example, when the sheet bundle Pb thicker than the user's finger is to be bound, the opening on the front surface of the post-processing apparatus **200** is closed by the protection cover **2981** and the protection switch **2982**. Then, it is detected that the user's finger is not inserted carelessly to secure the safety of the user.

The above-described embodiments may be implemented in combination with each other.

The present disclosure is not limited to specific embodiments described above, and numerous additional modifications and variations are possible in light of the teachings within the technical scope of the appended claims. It is therefore to be understood that, the disclosure of the present specification may be practiced otherwise by those skilled in the art than as specifically described herein, and such, modifications, alternatives are within the technical scope of the appended claims. Such modifications and alternatives are within the technical scope of the present disclosure.

In the above descriptions, the term "printing" in the present disclosure may be used synonymously with, e.g. the terms of "image formation", "recording", "printing", and "image printing".

The above-described embodiments are illustrative and do not limit the present invention. Thus, numerous additional modifications and variations are possible in light of the above teachings. For example, elements and/or features of different illustrative embodiments may be combined with each other and/or substituted for each other within the scope of the present disclosure.

What is claimed is:

1. A post-processing apparatus comprising:

a binding device configured to bind a sheet bundle;

a closing device configured to close an entrance to a binding position at which the binding device binds the sheet bundle;

a driver configured to move the closing device to a closing position at which the closing device closes the entrance; and

a changeover switch configured to perform switching to implement a state in which the binding device is able to bind the sheet bundle when the closing device moves to the closing position,

wherein the closing device includes:

an avoidance operation portion configured to move to the closing position to operate the changeover switch, and

a drive coupler coupled to the avoidance operation portion to move the avoidance operation portion to the closing position by a driving force caused by the driver,

wherein a coupling state between the avoidance operation portion and the drive coupler is released when movement of the avoidance operation portion to the closing position is prevented.

2. The post-processing apparatus according to claim **1**,

wherein the coupling state between the avoidance operation portion and the drive coupler is released when the movement of the avoidance operation portion to the closing position is prevented by a foreign object having a thickness larger than a thickness of the sheet bundle.

3. The post-processing apparatus according to claim **2**,

wherein the coupling state between the avoidance operation portion and the drive coupler is formed by fitting between the avoidance operation portion and the drive coupler.

4. The post-processing apparatus according to claim **1**, further comprising a coupling elastic member configured to apply a biasing force to the avoidance operation portion and the drive coupler to form the coupling state between the avoidance operation portion and the drive coupler, and

wherein the coupling state formed by the coupling elastic member is released when a force applied to the avoidance operation portion interlocked with the drive coupler is larger than the biasing force of the coupling elastic member, the force being caused when the movement of the avoidance operation portion to the closing position is prevented.

5. The post-processing apparatus according to claim **1**,

wherein a portion of the closing device that operates the changeover switch when the avoidance operation portion is moved to the closing position is biased in a direction opposite to a direction in which the avoidance operation portion is moved to the closing position, and

wherein the biasing force applied to the portion of the closing device is smaller than a driving force of the driver.

6. The post-processing apparatus according to claim **1**,

wherein the driver is also configured to supply a driving force for a binding operation by the binding device.

7. The post-processing apparatus according to claim **1**,

wherein the closing device includes a closing member configured to cover the entrance.

8. The post-processing apparatus according to claim **1** comprising:

a cover configured to open and close an opening serving as an entry path from an outside of the post-processing apparatus to the binding position; and

a cover detector configured to detect an open state and a close state of the cover,

wherein the post-processing apparatus is configured to switch between an executable state and a non-executable state of binding based on a combination of states of the changeover switch and the cover detector.

9. An image forming system comprising:

an image forming apparatus configured to form an image on a sheet, and

the post-processing apparatus according to claim **1**, the post-processing apparatus being configured to bind a sheet bundle of sheets on which images have been formed by the image forming apparatus.

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